AIRPORTS' CONNECTIVE ROLE IN MEGAREGIONS

A Thesis
Presented to
The Academic Faculty

By

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In Partial Fulfillment
Of the Requirements for the Degree
Master of Science in Civil Engineering

Georgia Institute of Technology

December, 2010

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ACKNOWLEDGEMENTS

I would like to show my gratitude to the professors at Georgia Tech who have helped me along the way in preparing my thesis work. Dr. Michael D. Meyer, Dr. Laurie A. Garrow, and Dr. Frank Southworth aided me in scoping my project based on my interests, guiding me continually throughout the process, and supporting my endeavor wholeheartedly.

I would like to thank Dr. Joseph Hummer for his continued encouragement beyond my graduation from NC State. I would not be where I am today without the guidance he's provided through his mentoring.

I am grateful to the America 2050 initiative for their support. It was a pleasure to work with Petra Todorovich and Yoav Hagler when I first started pursuing the topic of megaregions; their guidance was invaluable. This thesis would not have been possible without their aid in providing me data to pursue the topic.

I would most certainly like to thank my father, mother, and sister for being a strong foundation throughout my education, providing advice and listening to my concerns. I feel very fortunate to have a family that cheers me on always.

I lastly would like to thank Amy, who has seen me through all the tasks along the way, and has been patiently supporting my writing. Your encouragement means so much.

This thesis was aided by the support of the National Science Foundation. I am forever grateful to have received the honor of earning a Graduate Research Fellowship, which has allowed me the freedom to explore a topic which I have had a long-time interest in.

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LIST OF ABBREVIATIONS

BTS	Bureau of Transportation Statistics
CQGRD	Center for Quality Growth and Regional Development
DOT	Department of Transportation
FAA	Federal Aviation Administration
GDP	Gross Domestic Product
GMP	Gross Megaregion Product
GIS	Geographic Information System
IATA	International Air Transport Association
OAG	Official Airline Guide
NORTAD	North American Transportation Atlas Data
NPIAS	National Plan of Integrated Airport Systems
NTAD	National Transportation Atlas Database
RITA	Research and Innovative Technology Administration
VBA	Visual Basic

Megaregion Abbreviations

AZ	Arizona Sun Corridor
Casc	Cascadia
FR	Front Range
Gulf	Gulf Coast
Mid	Midwest
NE	Northeast
NCal	Northern California
Pied	Piedmont
SCal	Southern California
SFl	Southern Florida
TX	Texas Triangle
N-M	Non-megaregion Areas

SUMMARY

The megaregion spatial form has grown in prominence in recent years in planning thought. Using the models developed over the last decade, megaregions have been primarily used in discussions addressing freight movements and high-speed rail. The relationships between megaregions and the aviation sector is rather untouched in research. The purpose of this study is to examine the role airports play as transportation hubs for megaregions, and how the megaregions are connected through air traffic

Comparing the megaregions involved an empirical study using attribute data about the megaregions and the flows between them. All the U.S. airports were located within a megaregion if applicable, and were labeled as a non-megaregion area airport otherwise. The infrastructure in the megaregions was compared by density and type of airports, including an examination into airline hubs. The connectivity between megaregions, non-megaregion areas, and the international market was analyzed employing T-100 data, separating the analysis for the passenger and freight sectors. The top flows in the country were examined, along with the relationships each megaregion has individually. Particular attention was paid to the flows within a megaregion, noting which airports play the strongest roles.

Megaregions are much more active in air travel than non-megaregion areas due likely to a larger presence of airline hubs and greater infrastructure. The international component of the passenger and freight sectors is growing the fastest in relation to megaregions, but only for the freight sector is this the largest component. The largest component of the passenger sector is the flows between megaregions. Flows within

megaregions for the passenger sector are growing slowly and are declining in the freight sector, but short-haul air traffic continues to be the cause of congestion. The flows between airports in the megaregion are identified as being one of four different spatial networks. The megaregion is a suitable level to manage infrastructure investment to better prepare the regions for the coming growth. A megaregion-level institution is best suited to managing the issues which must be faced by the numerous jurisdictions and entities which are involved in the aviation industry of a megaregion.

CHAPTER 1

INTRODUCTION

Megaregions are a recent means of describing the urban development patterns that are occurring worldwide. These entities are a collection of metropolitan regions that have seemingly blended together; but more, they have interrelated cultures, industry, transport, and natural resources that provide connectivity and help to fuel economic growth. This large scale development pattern is exemplified across the United States, often spanning several hundred miles. At such a large scale, the transportation system that provides mobility for the region must be able to provide for the connections the residents and businesses of the megaregion will desire to make. Airports play a large part in providing connectivity within megaregions, but also link the megaregion's population and businesses to the rest of the country and around the world.

1.1 Context and Purpose

Emerging planning thought views megaregions as collections of metropolitan areas connected through economic, physical and environmental interaction (Ross, 2009). The physical interaction is facilitated by the transportation system, including the megaregion's road, rail, ports, and air networks. As an evolving concept, it is important to understand how the flow of people and goods within and between megaregions contributes to the economic health, stability, and growth of the region and the nation. Airports provide critical intra- and inter-megaregional linkages, while linking megaregions to non-megaregion and international markets. The connective traffic airplanes provide is only going to increase, and quite rapidly, enforcing the importance of understanding the characteristics of these connections now. Boeing (Crabtree, Hoang, Edgar, & Heinicke, 2008) and Airbus (Airbus, 2007) predict that both air cargo and passengers will more than triple during the next 20 years. This growth will need "to be accommodated … through the strengthening of existing city pairs, primarily between major centers of population" (Airbus, 2007). Capturing this growth in these hubs of activity, though, will require having capacity in the precise places where airports are currently the most congested (Tomer & Puentes, 2009). Having a strong focus on developing the world's largest airports can provide connectivity for passenger and freight traffic, while aiding the economic growth of a city. The National Academy of Engineering, however, is concerned about the fact that "we continue to design for one airport in a region, rather than dealing with all of the airports in the region at once" (de Neufville, 2008).

The purpose of this study is to examine the role airports play as transportation hubs for megaregions. The U.S. Department of Transportation sees megaregions as "places that operate - and thrive - at the center of a new economic and planning geography, one in which high value is placed on networks and on building attractive and healthy urban areas (Ross, 2008)." Under this definition, airports in megaregions must be understood as a network, and the geography of airport flows between megaregions must be seen in the context of the national system of economic ties. It is unknown whether the existence of a megaregion ultimately makes network connections within it stronger, or solely if a megaregion is identifiable by the transportation network which gives it structure. It is also unclear as to what degree megaregions and the airports within are a component of the national system. Air travel may or may not be representative of growth in megaregions, but travel patterns can be analyzed to see if they validate megaregion theory.

1.2 Research Problem

Ultimately, air facilities will face increased pressure to meet the challenge of a global economy that requires good connections. The inability of a megaregion's airports to serve such a function may result in a competitive disadvantage. Despite their importance, airports have had minor roles in megaregional studies and their effects need attention. Thus, there is a research need to examine the comparative size of the U.S. megaregions' airport systems, analyze the connectivity different megaregions have with each other through air travel, understand if and how the competitive position of megaregions have evolved over time, and determine the effect of airlines and international connections have had on the ability of different megaregions in the U.S. to compete successfully in the worldwide economy.

There is currently no broad understanding of the role of aviation in the megaregion theory. Unlike rail and automotive networks which have received attention from various megaregion geographers, the air system has been largely neglected. This sector is important for study because it not only affects the internal movements of a megaregion, but also the movements of people and freight between megaregions. These longer-distance connections are generally only considered on an airport or metropolitan level. To date the role of airports in the economic markets of megaregions has not been thoroughly studied.

This study is different in that megaregions are the geographical unit being analyzed in terms of air flows. One of the goals is to understand how well each of the eleven megaregions in the U.S. is handling its capacity needs to take advantage of expected growth in air travel. An inability of a megaregion's airports to serve such a function may result in a competitive disadvantage. By analyzing historic air passenger and cargo freight movements over the last two decades (representing a wide range of market conditions), it is possible to display the growth of connections between cities in the same megaregion and between other national megaregions.

Megaregions are a new topic, and it is not fully explored how travel operates within and between them. Exploring how air travel is a model for intra-megaregional connectivity will aid in understanding how people in a megaregion travel, and can provide insight into other connecting modal systems. Overall, the study's results will be an aid to help regions plan for all their air facilities as a whole, instead of independently.

CHAPTER 2

LITERATURE REVIEW

Megaregion theory is just beginning to be incorporated and applied into system analyses. Regional planners are working to not only delineate where megaregions exist in the U.S. and worldwide, but also are attempting to understand how the various systems within megaregions can be comprehended. Due to the relative newness of the megaregion concept, the role airports play within and between megaregions is yet to be fully understood. Studying this topic requires a background on megaregion theory, the U.S. airport system, and where the aviation field currently is in its application of megaregions.

2.1 Megaregions

The first mention of the megaregion was in reference to the Boston to Washington corridor in the northeastern U.S. in 1957 (J. Gottmann, 1957). Jean Gottman, a French geographer, makes note of how the cities in the Northeast have seemingly blended the boundaries of their social and economic networks, creating a large urban pattern stretching along the coast. Terming it a "megalopolis" in his book a few years later (Jean Gottmann, 1961) he begins to lay out criteria as to how this regional form can be defined. These remarks helped steer modern day geographers as they began to delineate the U.S. megaregions.

Today, the volume of research on megaregions is rapidly growing. Recently, the United Nations has noticed this trend, remarking that "cities are merging together to create urban settlements on a massive scale" (Moreno, Oyeyinka, & Mboup, 2010).

Worldwide, megaregions are blending city boundaries, what the U.N. (2010) terms as natural economic units, and will be the most impactful on the way people live and economies flourish. Domestically, efforts at education institutions and planning organizations have begun to study megaregions through formal research and discussion forums. In the past couple of years, the first book on megaregions (Ross, 2009) was published to collect in one place the variety of thoughts and discussions on megaregion theory.

2.1.1 Where and What Are the Megaregions?

There has been much debate over where the U.S. megaregions are and what models should be used to define them. The discussion is arising from numerous centers of research across the country. Some attempts are aimed at producing a unified national model. In addition, universities and planning organizations within many of the megaregions have sought out their own analysis on the megaregion in which they are located.

2.1.1.1 National Megaregion Studies

The study which brought discussion of the national megaregions into the spotlight came out of the Metropolitan Institute at Virginia Tech (Lang & Dhavale, 2005), using the term "megapolitan" in reference to the smaller geographical entity of the metropolitan area. Using the county as the smallest component of their study, megaregions were defined by projected populations, number of cities, a shared cultural identity, transportation networks, geography, and metro- and micropolitan continuity. The study also attached names to the megaregions, ten identified at the time, using regional terminology for how the local and national population referred to each specific collection of cities.

America 2050, an offshoot of the Regional Plan Association, began focusing on megaregions as their basis for what was felt to be the next important geographical unit that planners would work at in the coming decades. Using five criteria to identify the megaregions (environment, transportation infrastructure, economic linkages, patterns of development, and cultural identity), the organization laid out ten megaregions, later to become eleven, which stood out in the national landscape as centers where the strongest economic production occurred (America 2050, 2006). The aim of the ongoing project is to coordinate goals in infrastructure and cooperate over environmental and development issues.

More recently, the Center for Quality Growth and Regional Development identified a set of megaregions based strongly on the freight networks between metropolitan centers (Ross, Woo, Barringer, West, & Doyle, 2008). Emphasizing the relationship between core areas and the areas of influence surrounding them, a process is developed that uses regional characteristics to work out the precise geographic area of each megaregion. The resulting megaregion map consists of ten megaregions, and breaks the historical concept of the megaregion by splitting into two parts Gottman's original megalopolis.

2.1.1.2 Megaregion-specific Models

Many efforts have been made on a megaregion-by-megaregion basis to further understand how the theory can be applied to local conditions. The first of these studies was done on the Northeast corridor, a new look at Gottman's megalopolis (University of

Pennsylvania School of Design, 2005). The work from this studio was the spark, in fact, to start America 2050.

Since then, studies in various university planning studios and research institutes have occurred for the Piedmont megaregion (Contant et al., 2005), the Midwest megaregion (Delgado et al., 2006), the Texas Triangle (Butler, Hammerschmidt, Steiner, & Zhang, 2009), and Cascadia (Seltzer et al., 2005). In addition, planning policy organizations have performed studies in Northern California (San Francisco Planning And Urban Research Association, 2010) and Southern California (Kern County Council of Governments, 2005).

These various studies have all taken their own spin on their own megaregion, focusing often on a single aspect of the megaregion, such as transportation, the environment, or economic goals. Many of the studies are integrated with America 2050 through outreach efforts, or have focused on the America 2050 as their foundation for study.

2.1.2 Implications of Megaregions

With the wide variety of studies ongoing to identify megaregions, there have been efforts to consolidate the existing knowledge into a workable theory. The U.S. Department of Transportation (Ross, 2008) examined the history of megaregion theory and drew conclusions about what the variety of studies had used as identification criteria, and how this could be combined into a universal megaregion model. Ross's book on megaregions (2009) collected ideas from researchers in the U.S. and abroad on the implications of megaregions on the environment, transportation, politics, and the economy.

One of the key issues surrounding megaregions is that this new spatial form will overtake the metropolitan area in the way we picture our world. The extended networks of the megaregion encompass the greater share of the nation's population and are the areas where growth is occurring the quickest (America 2050, 2006). It is argued that the megaregions will become the recognizable gateways to nations, and will be how we organize our infrastructure planning efforts (America 2050, 2008). The reason behind this line of thinking is that the challenges that the world faces do not pay attention to boundaries, and sustainable planning will require working around the forms that have grown organically (Dewar and Epstein 2007).

The megaregion has certainly found respect on the worldwide stage. Just like metropolitan areas are the components of a nation's economy, so thus is the megaregion operating similarly on the worldwide scale. "National borders no longer define economies. Instead the mega-region has emerged as the 'natural' economic unit" (Florida, Gulden, & Mellander, 2007). The extended networks that define megaregions, reaching out from the city cores, make them powerful agglomerations. This contiguous development is an indication that there is integration of all the components economically within the megaregion. It is believed that the megaregion will redefine the world's trade systems over the course of the next century (America 2050, 2006). As described by Ross et. al (2008), their prime purpose on the worldwide stage is to conduct international trade and integrate in global economic markets. The possibility of the megaregion as a financially viable power is reason enough to identify and understand them.

The large size of megaregions will require organization systems that have only begun to be created. There is a need to create underlying institutional structures that are able to manage policy issues in order to provide functional integration to all the parts of the megaregion (Teitz and Barbour 2007). The implication of the existence of the megaregion form is that metropolitan planning organizations and government councils will need to work together to address the issues of the growth spilling over boundaries. According to Dewar and Epstein (2007), the reason to have such planning organizations and methods at the megaregion level is to remain competitive on an international scale. The authors indicate that Europe and China are already planning for megaregions. It is of utmost importance that cities are able to look at problems beyond the scope of the city border. Issues like freight and the environment will need an authority to aid in articulating the issues to all involved parties.

2.1.3 Megaregions and Transport

Transportation is a key issue in megaregions, with much of the focus geared today towards high-speed rail (HSR). America 2050 has had a focus on HSR for the past five years, aiming to stimulate a national discussion on creating an infrastructure plan with HSR as a key component. The efforts have resulted in a system of evaluating corridors across the country, with a focus on the megaregions (Hagler & Todorovich, 2009), using city pairs as a basis for the analysis. The discussion surrounding megaregions and HSR has likely done the most to raise the profile of megaregions to the national level conversations. There is agreement that HSR is a prime megaregion issue, as the spatial spread of the megaregion is at the optimal distance for HSR to be constructed (Hagler & Todorovich, 2009; Ross, Woo, Barringer, West, & Doyle, 2008; Taylor & Yaro, 2010). There have been numerous studies done on HSR in the U.S., with the federal government just now funding new systems. Using the Northeast Corridor as an example, Taylor and Yaro (2010, p.14) describe the necessity of a megaregional government institution that would manage HSR plans and ideas, with the authors providing a conceptual framework for how such an organization would be governed.

Highway systems have also received plenty of focus in the discussion of megaregions and their growing transport issues. Megaregions continue to attract the country's populace and businesses, and will universally struggle with providing internal mobility along their road networks (Ross, Woo, Barringer, West, & Doyle, 2008). There will need to be investment in the highway systems to meet the increased demand.

Airport systems in megaregions have received minimal attention in the majority of megaregion discussions. The needs and expectations of travelers going long distances in general are not well analyzed, as there is no public agency tasked with addressing travel preferences or accessibility to long distance markets (Coogan et al., 2010). Within the U.S., there have been regional aviation institutions that could potentially be models for future megaregional aviation system planning. The New England Regional Airport System Plan is the largest and most likely form of a megaregion aviation plan, as it crosses multiple jurisdictional boundaries. The Bay Area's plan in California is at a smaller scale, although it makes up a large portion of the Northern California megaregion. Its issues are less cross-jurisdictional but still require great coordination. The plan surrounding the Washington, D.C. area in addition could be a model for future megaregional planning, as many cities and two states are involved in the planning process.

2.2 Status of U.S. Airports

The U.S. airport system is the most active in the world. The combination of a nation with a large geographic expanse and a mobile wealthy population has resulted in the U.S. airports being some of the most heavily used in the world (Airports Council International, 2010). Five of the top ten airports in the world by passenger volume are in U.S. cities: Atlanta, Chicago (ORD), Los Angeles, Dallas, and Denver. Its freight airports are also some of the world's largest, with three in the top ten: Memphis, Anchorage, and Louisville. Because the U.S. system is already well developed, its growth is not as rapid as that occurring in nations with burgeoning airport networks such as China and Brazil.

One of the key issues in the national collection of airports is capacity. More than ever the airports in the U.S. are limited in their ability to provide for passengers and freight by the capacity of their runways, terminals, and access systems. The Federal Aviation Administration's (FAA) FACT-2 study (2007) reported that in 2007 four airports and one metropolitan area were restricted by capacity. These numbers skyrocket by 2025 as the desire to move and ship by air increases. The airport system is not prepared for such growth, and it is suggested that new runways and new commercial airports get constructed, backed by regional studies performed to understand how to prepare for the growth (Federal Aviation Administration, 2007). The FACT-2 study provides specific criteria on how to choose the airports that most need additional capacity, and describes simulation models that can be used in estimating the future demand. Looking elsewhere may not provide solutions; the U.S. air system already approaches capacity needs in a liberal fashion, as compared to Europe, and policies allow airports to make maximum use of their runways (Odoni & Morisset, 2010). It is clear with the growth to be seen, the future of the U.S. system is at risk if capacity needs are not met.

The issue of national airspace capacity is primarily focused on the primary hub airports. Nearly all of the U.S. passengers arrive or depart from one of the airports in 26 metropolitan areas. Due to the consolidated nature of airports, with passengers and freight coming through key hubs, the success of the country depends on the success of these few metropolitan airports (Tomer & Puentes, 2009). Due to limited options for traveling even moderate distances there is a large sector of the U.S. airline industry which focuses on short-haul flights. This type of traffic unnecessarily congests the airports and the airspace, an inefficient use of the limited capacity. Using the top 100 metropolitan areas as a study set, Tomer and Puentes (2009) methodically determine the trends in the national system. Their results lead them to conclude that the current U.S. policy is out of sync with the source of most passengers – the largest metropolitan areas – and not enough funding goes to these airports. It was seen that passengers bypassed smaller regional airports to drive to large hubs, and thus the demand is coming from across larger areas. One of the recommendations Tomer and Puentes (2009) put forward is the complete privatization of airports, with congestion pricing for peak periods.

2.3 Airports and Connectivity: World Cities

Between megaregions, information must pass for business and socialization to occur. In the 21st century, information exchange occurs through electronic communication modes, such as the internet, and through the movement of people between places. On a national and global scale, this latter exchange is primarily achieved by air travel. A significant field of research on world cities has focused on the importance of airport flows as a measure of world connectivity. The topic of world cities was made famous by Saskia Sassen, whose seminal book changed the field to focus on advanced producer service firms who made use of the cities with strong knowledge industry sectors (Sassen, 1991). The concept of a world city expresses a form where cities reach beyond their local sphere of influence, and interactions occur on a worldwide scale between the most prominent urban centers on the planet. The concepts in this area of study are not far removed from megaregion theory, where interactions are perceived to occur on a larger scale. The tenets of world cities and the concepts of using air flows to measure their interaction is a model for studying megaregion interaction.

The network of world cities is formed by the connections these service agglomerations have with each other across the globe. To be a world city, thus, a city needs a strong knowledge economy that can ensure participation in the network of information and people flows. The primary cities of megaregions often are these world cities. The high concentration of the knowledge workforce in these cities and surrounding regions causes increased interaction and transfer of knowledge, an advantageous resource for industries looking to reduce the cost of searching for and using skilled high-tech labor (van Geenhuizen & Doornbos, 2008). For knowledge workers to reach their full potential, however, they require access to other knowledge centers around the world. Facilitating this need are international airports, where knowledge workers are able to travel to visit other knowledge industries, interact with each other in transit, and attend conferences near airports. Business firms have already recognized the importance of being near a busy hub airport, given a strong correlation between professional employment in a metropolitan area and the number of flights per day at the airport (Fik, Ivy, & Malecki, 1995). It has been shown statistically that the causal factor in this relationship is the airport (Button & Lall, 1999), with the volume of traffic leading to increased number of jobs in the knowledge sector, particularly high-technology businesses. Access to the airport thus ends up being a large influencing factor in being able to participate in the world city network (van Geenhuizen & Doornbos, 2008).

With the importance of the airport established, the manner of examining world cities is done through measuring the air passenger flows between the world city network as a surrogate measure of connectivity. Keeling's (1995) study was the first to recognize that the importance of a city could be evaluated by its airport infrastructure, acknowledging that face-to-face communication is still necessary for the knowledge economy and airports are the manifestation of the interface between cities. This approach of using infrastructure, particularly airports, to conduct empirical research on the topic "recognizes that well-connected cities are typified by the presence of vast enabling infrastructures" (Derudder and Witlox 2008, p. 307). Under this assumption, the most important world cities would have the world's most important airports, a testable hypothesis using already collected airline data.

Determining how to measure the importance of a world city through an analysis of its airport has been a contested issue (Derudder and Witlox 2005, 2008). To judge a city's connectivity, air flows between world airports is necessary. Some issues arise though when using most data sources. First, most airport flow data comes in the form of segment data, as opposed to market data, a problem in an age of hub-and-spoke networks in the airline industry. The trend has been to report the former, mostly due to ease of collecting, causing an uptick in many analyses for airports that serve as airline hubs (Derudder and Witlox 2005). In addition, sources of worldwide data flows focus on international flows only, and flows internal to a nation are disregarded. This results in a negligence to properly attribute importance to two world cities in the same country (Derudder and Witlox 2008), such as flows from Shanghai to Beijing. Derudder and Witlox (2008) also point out that airport flows do not solely capture the importance of the world city knowledge network, but encompass many types of traffic, notably tourism. High passenger flows to Las Vegas therefore may insinuate world city status, but the true nature of its prominence is likely not its knowledge network connection, but instead reflects its role as a tourist destination.

Using flows between cities, once an acceptable database has been constructed, geographers have created lists of world cities that show connections as well as importance. Demonstrating connectivity, Derudder and Witlox (2005) compile a list of the world's most important economic cities and the flows between them. They rank the cities by the number of passengers traveling in a given time period and make note of the pairs of cities which have the largest volumes of flows. This attribute comparison allows them to pick out which cities are most connected on the worldwide network, and thus which are the top world cities. This also can include a precursor regional component that helps in establishing connections amongst less prominent world cities that dominate a cluster (Smith and Timberlake 1998; Witlox et al. 2004). A clique analysis further helps define these connections to draw out hierarchal tendencies (Shin & Timberlake, 2000). In another method, cluster analyses using various centrality measures allowed for both a hierarchy and network display of the world cities (Choi, Barnett, & Chon, 2006).

Incorporating time into the analysis by looking at the flows between world cities over a number of years allows a further understanding into how world cities have changed in prominence due to historic events and growth (Smith and Timberlake 2001, 2002).

The use of airline data to support world city connectivity is a viable concept to be applied to other larger scale spatial analyses. Megaregions lend themselves to this due to the nature of industries that are found in the cities of megaregions and the need to understand what connections exist between them.

2.4 Spatial Analysis of Regions and Airports

Looking at airports spatially has been done on numerous levels. Regional, national, and worldwide studies have all been performed, using various spatial constructs as the fundamental unit of analysis. As exemplified in the previous section, analysis of world cities is just one area in which the analysis of how airports relate to each other, as the ports of flows for their respective cities, is receiving attention. The megaregion, though, has only just begun to be understood spatially in terms of airports.

Metropolitan area analyses of spatial airport relationships are commonly performed. Using the metropolitan area as a spatial unit is popular due to its well understood nature in the literature of geographers, and the broad amount of data which is available for measuring the space. Being able to relate details such as employment growth due to the linkages coming out of an airport are possible due to data availability, and allow for conclusions on which cities are poised for capturing international job growth and have international network integration (Irwin & Kasarda, 1991). Metropolitan area airport analyses have also been done over time, examining where growth has occurred and reasoning how population and employment growth can be attributed to the data attached to the airport (Goetz, 1992).

A higher organization level of space has also been attempted, focusing on the state, as a way to better understand regional patterns (Bhadra & Wells, 2005). The attempt is to detach the analysis from the influence of individual cities, and understand better how the air flows are affected by their origin and destination as it relates to position in the country. At these larger scales, it is also possible to have flows within the spatial area, and Bhadra and Wells (2005) find a relationship between state size and intrastate travel. It is their conclusion that size alone does not mean heavy intrastate travel will occur, but it is a necessary condition. The study also found that the location of a state within the nation influenced its travel patterns, with being located along the coast having a positive effect on air travel. The authors debate whether states and local jurisdictions should compete actively to garner increased airline services, but warn that the attributes of a spatial area will limit the impact of infrastructural investments. For example, airline hubs can only function well in cities that already have sufficient size in population and economic production to support hubbing activities, as there is an agglomeration effect from the city with such an endeavor.

2.4.1 Megaregion Airport Analysis

Megaregion level airport analyses have not been performed on a nationwide scale, but there has been some attention given to how airports function within the most capacity-starved megaregions. ACRP Report 31 focuses on the airport systems of the

Northeast and the two California megaregions, referring to them as the East and West coast study areas, respectively (Coogan et al., 2010).

The analysis on megaregions performed by Coogan et al. (2010) is an empirical study looking at the primary airports in the megaregions. The megaregion definitions used break the megaregion up into its smaller regions, and in the case of the East Coast study area, even includes adjacent regions such as upstate New York and southern Virginia. The study has a strong focus on the internal flows between the airports in each study area, examining the scale of travel and congestion to determine what that means for needed extra capacity. Delay at the airports is a focal point, as the authors use this argument as a jumping off point to evaluate parallel modes such as HSR. A detailed airport-by-airport analysis looks at airport choice and where people are traveling to in a given population set. Lastly, due to the focus on capacity, there is a discussion on the potential for demand management at the airports and what the implications would be.

Although the report looks significantly at HSR as an alternative for intramega traffic, it also provides suggestions on how to put together and manage a megaregion air authority to improve the airport planning process. The suggestion is made for further analysis on how alternative forms of hubbing could relieve the major airports in the megaregions studied, commenting that “regional solutions could gain optimized capacity from a ‘family of airports’ concept” (Coogan et al., 2010, p.17). Procedures to support such an endeavor would be backed by analysis tools that capture the true origin and destination of passengers, and not just the part of the trip between airports. The result would be a multi-airport planning process that could capture the potential of underused airports and provide a better trip experience to the megaregion traveler.

The analysis of the two study areas, consisting of three megaregions, is a strong basis for how to evaluate the U.S. megaregion airports. Empirical analyses using attribute data is essential to forming an understanding of how megaregions are moving their populations internally. A larger scale analysis incorporating all megaregions and using flows to measure the interaction between megaregions, similar to what is done with world cities, is the next reasonable step in the process of comprehending the full picture of megaregions and their air systems.

CHAPTER 3

METHODOLOGY

The framework for this project involves assessing how megaregions, and the airports within them, operate as hubs of airline traffic. Airline passenger and freight movements over a twenty year period were obtained from the Office of Airline Information's T-100 Market Database (OAI/US DOT). Using this data source, air travel demand from the hub cities is measured by four categories of destinations: to other metropolitan areas within the same megaregion, other national megaregions, non-megaregion destinations, and international destinations. These four classes of flows are compared by the volume of freight and passenger flows. The flows are examined to see which megaregions are most active in air travel. An assessment is also done to see how megaregion air travel has changed over time.

Megaregions are stratified based on the number of major airport hubs each contains, and classified based on a region's other airports' distribution and services. Each megaregion's capacities and flows are assessed to see which have airport networks that best operate to meet the population's and economy's demands, and the extent to which the airports compliment or compete with each other for the megaregion's demand.

3.1 Data Sources

This project used several data resource, most of which are available to the general public. Only the megaregion GIS shapefile was used by the permission of a non-federal government institution.

3.1.1 Origin-Destination Flows

The data used in this study comes from the Air Carrier Statistics database. The database is also known as the T-100 data bank due to the name of the form which U.S. air carriers fill out to report the data. Data is reported monthly and is collected by the Office of Airline Information, part of the Bureau of Transportation Statistics (BTS), which itself is a part of the Research and Innovative Technology Administration (RITA) of the U.S. Department of Transportation (DOT). The data is compiled and reported as a complete data set of all air travel occurring within, to, and from the United States, listed by origin-destination pairings. This differs from the Airline Origin and Destination Survey, which is a ten percent sampling of all airline tickets for U.S. air travel. The T-100 data set considers the territories held by the United States as domestic markets.

Two sets of data, domestic and international, were acquired from the BTS website. Both of these datasets are market data, as opposed to the alternatively available segment data. Segment data breaks trips into links, such that a trip involving one connection is considered to consist of two segments. The market data set, on the other hand, would consider this one trip. Hub airports thus are overrepresented in the segment data set. The reason for choosing market data was that it allowed analysis on the actual origin and destination of travelers' trips. In this analysis, there is no desire to capture the effect of hub airports, and market data removes the bias that exists for hubs in the segmented data.

For example, because Atlanta Hartsfield-Jackson International Airport is a hub for both AirTran Airways and Delta Airlines, it will have a significantly larger representation in the segment data set, as many passengers using Delta's and AirTran's networks make connections in Atlanta. The airport is considered a destination on the first leg of a trip, and an origin on the second leg. In the market data set, Atlanta's airport would not show up at all; instead the actual origin and destination of the traveler's itinerary are reported.

The domestic data set encompasses all trips occurring in the U.S. internally. Nineteen years worth of market data were downloaded from the BTS website. The attributes of these acquired data sets were organized by month and year of travel for each pairing of origin-destination pairs and operating airline. Airport codes are reported as those in the Official Airline Guide (OAG), which are all recognized by the International Air Transport Association (IATA). Origin and destination airport pairs are not commutative. The specific attributes are listed in Table 3.1:

Table 3.1: Attributes from T-100 Domestic Data

Enplaned Items:	**Origin-Destination Attributes:**
Passengers flown	Distance between origin and destination (miles)
Freight Flown (pounds)	Origin: IATA Airport Code, City Name, City Code, State, and World Area Code
Mail flown (pounds)	Destination: IATA Airport Code, City Name, City Code, State, and World Area Code
Airline Attributes:	**Time Attributes:**
Unique Airline Code	Month
Airline ID number	Year
Airline Name	

The second data set encompasses all trips that begin or end internally within the U.S., and for which the corresponding other end is in another country. From the BTS website, nineteen years worth of market data were downloaded. This data set was similar to that of the domestic data except for the attributes for Origin and Destination. Instead of the Origin state and Destination state, the following specific attributes included are shown in Table 3.2:

Table 3.2: Additional Attributes from T-100 International Data

Origin-Destination Attributes:
Origin: Country Code and Country Name
Destination: Country Code and Country Name

All services types were included in the dataset, both commercial and non-commercial. This is different from the method used in a Brookings study of airport congestion which excluded non-commercial service (Tomer & Puentes, 2009). Given that this study is attempting to capture all types of passenger and freight flows, regardless of service type, the decision was made to include all service types in the analysis.

Within the T-100 database, there are 1,880 airports listed as having some service during the period 1990-2008. The varieties of airports that exist in the database represent all the types of U.S. facilities, from large hubs in major metropolitan areas to small airstrips that do not receive scheduled service.

3.1.1.1 Rule Changes to T-100

It is acknowledged that during the middle of the 1990-2008 study period, there were rule changes implemented to the reporting system of the T-100 dataset. According to a memo listing these changes (Bright, 2002), the largest effect is felt in the area of domestic freight. Prior to October 2002, domestic all-cargo operators, such as UPS and FedEx, were not required to report their freight flows. Another significant change, although less apparent in the data, is foreign air carriers now had to report operations for small aircraft, when previously only aircraft over 60 seats required reporting. In addition, small certificated and commuter air carriers for the first time had to report their operations. A final change affected joint service operations, in that the air carrier whose crew was performing the flight operation was required to report the flight to the T-100 system.

3.1.2 Airport Locations

Geographic Information System (GIS) data was gathered on airport location from the 1998 North American Transportation Atlas Data (NORTAD) and the 2009 National Transportation Atlas Database (NTAD) 2009. The point file Public-Use Airports was used to spatially locate the airports in the GIS environ. There is attribute data for the physical and operating characteristics of the airport and usage categories. Only airports that exist for the public's use are included in the NORTAD and NTAD datasets. Unlike the T-100 data, the airport codes in the two spatial databases are assigned by the Federal Aviation Administration. These are not always the same as the IATA codes.

Both the NORTAD and NTAD GIS databases were initially retained because of the changes that occurred historically within the U.S. airport system. Between the release of the 1998 NORTAD and 2009 NTAD, many airports in the U.S. changed either FAA or IATA airport codes. The T-100 data, because it extends back to 1990, thus would need to be carefully handled when attributing IATA codes spatially in these atlases.

3.1.3 Airport Characteristics

The FAA separates airports into different hub designations in order to determine funding levels within federal programs. The National Plan of Integrated Airport Systems (NPIAS) is a list of all the airports in the United States. The dataset for 2007-2011 was used to classify each of the airports in the T-100 database.

Within the NPIAS list is a designation of Primary airports, which handle at least 10,000 passengers per year. The largest airport within this division is a large hub airport, which has at least 1% of all annual U.S. passenger movements. Below this are medium hubs, which have between 0.25 and 1% of U.S. passenger movements; small hubs with between 0.05 and 0.25%; and non-hubs, which have above 10,000 but less than 0.05%. Airports in NPIAS that have less than 10,000 annual passengers, but greater than 2,500 annual passengers are classified as non-primary airports. General aviation airports are defined as having fewer than 2,500 passengers each year, and are the smallest category in the NPIAS report. Reliever airports are general aviation airports that can be used to relieve large primary airports when necessary, and are designated as such in the report.

3.1.4 Airlines

For part of the analysis, the location of airline hubs in the U.S. in relation to megaregions was needed. To do this, it was necessary to identify the top airlines by volume in the U.S., both freight and passenger, during the period of the study, 1990-2008.

3.1.4.1 Passenger Airlines

The data for choosing these airlines comes from the T-100 dataset from 1990 to 2008. To choose which airlines to include in the passenger airline hub analysis, it was desired to include the top 15 airlines by passenger volume in the time period of the dataset. This included all current legacy airlines, the largest low-cost carriers, and the most well-known former major airlines. These airlines and their respective passenger volumes during the study period are displayed in Table 3.3.

Table 3.3: Top 15 Passenger Airlines by Volume, 1990-2008

Airline Code	Airline Name	Passengers (millions)	Bought by:	Affiliate of:
DL	Delta Air Lines Inc.	1654		
AA	American Airlines Inc.	1626		
UA	United Air Lines Inc.	1350		
WN	Southwest Airlines Co.	1209		
US	US Airways Inc.	991		
NW	Northwest Airlines Inc.	932	DL	
CO	Continental Air Lines Inc.	776		
HP	America West Airlines Inc.	327	US	
TW	Trans World Airways LLC	270	AA	
AS	Alaska Airlines Inc.	234		
MQ	American Eagle Airlines Inc.	184		AA
FL	AirTran Airways Corporation	149		
XE	Expressjet Airlines Inc.	142		CO, UA
EV	Atlantic Southeast Airlines	113		DL, UA
B6	JetBlue Airways	107		

The current legacy airlines and their affiliates make up the largest portion of this list. The legacy airlines are Delta Air Lines, American Airlines, United Air Lines, US Airways, Continental Air Lines, and Alaska Airlines. Their affiliates include American Eagle Airlines, Expressjet Airlines, and Atlantic Southeast Airlines. The high-profile low-cost carriers are Southwest Airlines, AirTran Airways, and JetBlue Airways. The list also includes three major passenger airlines that were bought out by other airlines during the study period: Northwest Airlines, America West Airlines, and Trans World Airways.

3.1.4.2 Freight Airlines

The data for choosing these airlines also comes from the T-100 dataset from 1990 to 2008. Table 3.4 displays the two airlines that were used in this study. Federal Express and the United Parcel Service are by far the leading freight only air carriers in the nation. After these two, most of the carriers of freight in the database are the passenger carriers that carry the most freight, including many international carriers. Since the purpose of identifying the top airlines by volume was for hub identification, these passenger airlines are already accounted for.

Table 3.4: Freight Airlines by Volume, 1990-2008

Airline Code	Airline Name	Freight (millions of pounds)
FX	Federal Express Corporation	84580
5X	United Parcel Service	59906

3.1.5 Airline Hubs

Subsequent to identifying the major airlines for the study, each of the airlines' current and past hubs were located. Wikipedia was used as a reasonable source for each airline's history during the study period of 1990-2008. Any airport that served as a major focus of airline operations for an airline during that time was attributed to the hub dataset. Four types of hubbing activities were recorded, based on how the airline identified its operations at an airport:

Passenger Airlines: Passenger Hub, Focus City*, Former Hub
Freight Airlines: Freight Hub
**Note: Focus Cities were termed by some airlines as Secondary Hubs*

3.1.6 Megaregions

The megaregions shapefile was acquired from America 2050, part of the Regional Plan Association. America 2050's megaregions were chosen over other nationwide options such as those from the Center for Quality Growth and Regional Development (CQGRD) or the Metropolitan Institute and megaregion-specific studies such as those performed by the University of Pennsylvania on the Northeast, Georgia Institute of Technology on the Piedmont, San Francisco Planning and Urban Research on Northern California, Kern County Council of Governments on Southern California, the University of Michigan on the Great Lakes, the University of Texas on the Texas Triangle, or Portland State University on Cascadia. The reason for the decision to use America 2050's megaregions is outlined in the following section.

3.1.6.1 Megaregion-specific Studies

This research project is being conducted on a national scale, and thus all megaregions will need to be considered in terms of the airports that reside within. Using a conglomeration of megaregion-specific studies was considered because it would create a system of megaregions based on how those familiar with the area view it. This viewpoint could be considered more authoritative because those crafting a megaregion's boundaries are more familiar with the characteristics of the region.

The reasoning as to why there is a benefit in using megaregion-specific studies can also be considered a detriment. There are major downsides to using a combined map of megaregion-specific studies. First, not every megaregion has had a study performed on it by a group internal to the megaregion's boundaries. There would be a need to supplement from national megaregion studies. Perhaps more importantly, each of the megaregion-specific studies use a different methodology for boundary delineation, creating an inconsistent set. It could cause some airports to be excluded from a megaregion when under another megaregion definition, in the same set, they may have been included. Lastly, each of the megaregion-specific studies were conducted at different times. Population and economic growth and decline may have produced different megaregion boundaries had these megaregion-specific studies all been conducted simultaneously and with the same data. Due to inconsistency between megaregion-specific studies, this option was not used.

3.1.6.2 Other National Level Studies

The clear benefit to using a national level study of megaregional delineation is a consistency of method. Each megaregion would have boundaries that were determined using the same set of tools and decision-making processes. Each of the three national-level studies make use of different tools and data, considering different characteristics to craft the shape of each megaregion. The method behind each system is described in the literature review, but two points as to why America 2050 was used are outlined here.

The set of megaregions created by America 2050 is similar in many ways to those of the Metropolitan Institute and CQGRD. All have the approximate same metropolitan areas included in the megaregions, and group them in roughly similar ways. What stands out though is the reasonableness that exists in the America 2050 megaregion set. CQGRD's megaregions stand out as strikingly different compared to the other megaregion concepts that exist. Most apparent is the splitting of the Northeast (DC-Boston) megaregion in two: a DC-Virginia megaregion and a Northeast megaregion only consisting of Philadelphia, New York, and Boston. The Northeast was the original megaregion as defined by Jean Gottman in 1957. The decision by CQGRD to split up the original megaregion into two parts is a concern. It is one of the most familiar megaregions both nationwide and around the world, and is consistently referenced as an example of what a megaregion looks like.

The limited value of the CQGRD model is also demonstrated in the combination of Northern and Southern California into one gigantic megaregion encompassing nearly the entire state of California. This displays a lack of concern for regional culture, something America 2050 makes use of in their definition. The two parts of the state are strikingly different, and all other megaregion studies take this into account. Even the leading megaregion discussion coming out of California (Teitz & Barbour, 2007) specifically discusses California as having two megaregions, and supports this by referring to the differences between the Northern and Southern California conglomerations. The authors recognize the strong distinctions in industry, political and social structures. In addition, they note the different styles of urban development, while adding that the existence of separate megaregions exists in public perception too. In addition, it is not practical to argue for megaregion institutions if a megaregion is already an institution in itself: the state government. Teitz and Barbour (2007, p.1) argue this point, stating California should not be considered one large megaregion because the state has never worked as such. They identify the state's strong "home rule" tradition by discussing how it has been local and regional level movements over time that have shaped the state’s urban growth more than the state government ever has (Teitz and Barbour 2007, p. 7).

Megaregions are a new concept to many policymakers across the country, and America 2050 has used their set of megaregions in conferences delivered nationwide. Although the Metropolitan Institute’s definition is reasonable, it falters in the face of America 2050’s megaregion set because it has not been used as a policy tool or furthered beyond definition. Due to America 2050’s outreach effort, policymakers in each megaregion are already having conversations with the image of the America 2050 megaregion map in their mind. The America 2050 megaregions are the most common set used in news articles on the issue, and thus have been introduced into the public mindset. Although there may be changes to America 2050’s map over time, as they improve their definition and tweak which spaces are considered megaregions, they have a strong base grounded in infrastructure, environmental, and economic systems. Given that America 2050 has pushed hard to get the word out through discussions in each megaregion, and used their maps along the way, it would be beneficial to have conversations on airports with this same set.

For reference, America 2050’s megaregions are listed in Table 3.5 along with their size, population, population density, and gross megaregional product (GMP). Figure 3.1 shows a national map of the megaregions.

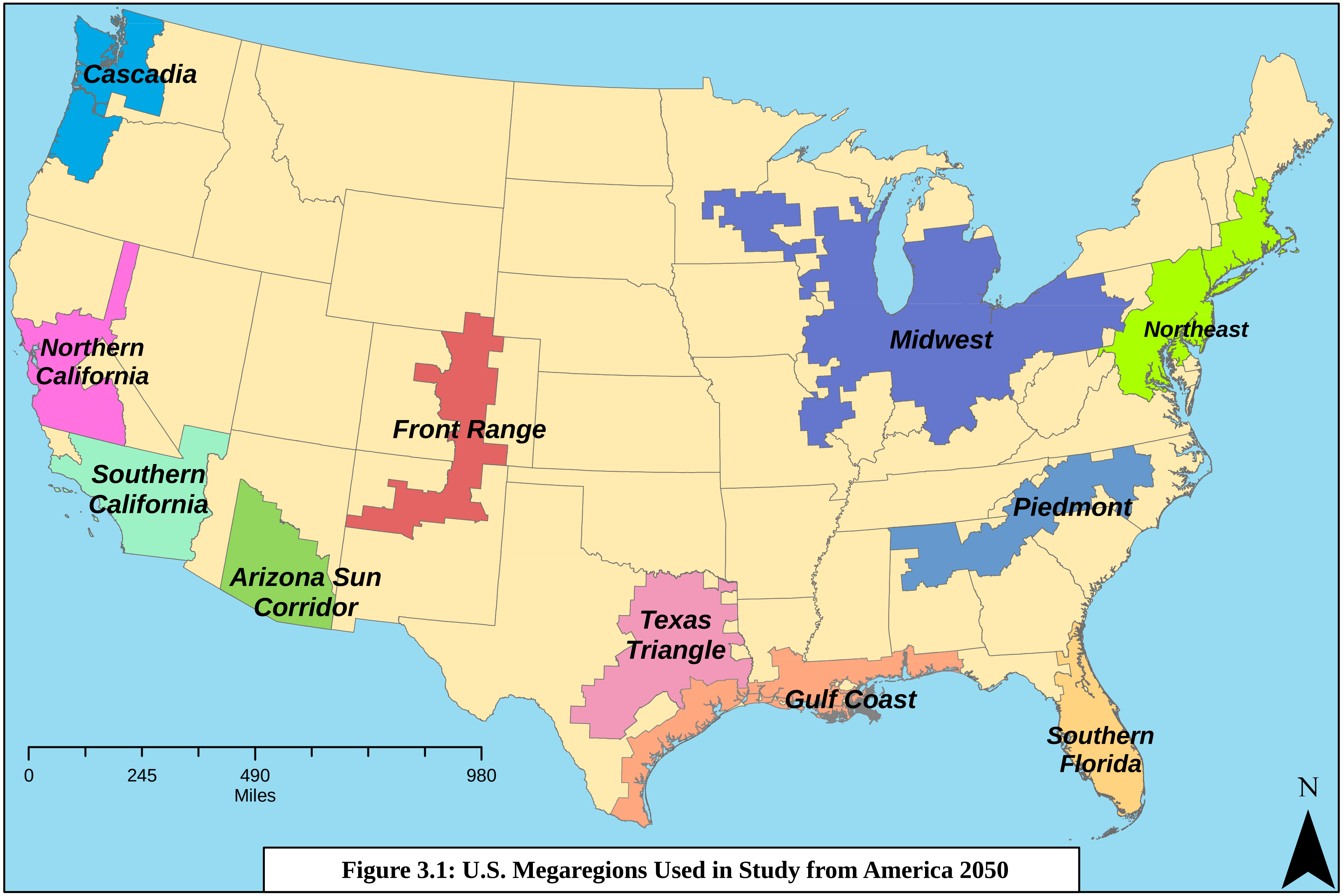

Figure 3.1: U.S. Megaregions Used in Study from America 2050

Table 3.5: America 2050 Megaregion Statistics

Megaregion	Counties	Size (sq mi)	2000 Population	2000 Density (per sq. mi.)	2005 GMP ($ billions)
Arizona Sun Corridor	8	48809	4535049	93	191
Cascadia	34	47341	7400532	157	337
Front Range	30	56731	4733679	83	229
Gulf Coast	75	57834	11747587	197	524
Midwest	388	205032	53768125	262	2073
Northeast	142	61634	49563296	800	2591
Northern California	31	48172	12724861	265	623
Piedmont	121	59582	14855052	250	486
Southern California	10	61865	21858662	353	1037
Southern Florida	42	38784	14686285	383	608
Texas Triangle	101	84768	16131347	189	818
Megaregions	967	772860	206780494	268	9199
Rest of Country	2117	2245370	73508817	33	3235
United States	3085	3018230	280289311	93	12434
Megaregion Percent	31%	26%	74%	n/a	74%

(Source: America 2050, 2008, p.11)

3.2 Data Processing

The monthly T-100 data was aggregated into annual data. Each aggregation was by the unique carriers operating between unique origins and destinations. In order to do this, the data was first sorted by origin, destination, carrier, and month, and Visual Basic (VBA) was used for aggregating. All years were combined into one spreadsheet. Domestic and international datasets were aggregated separately due to their different attributes, and then merged at the end.

3.2.1 Managing T-100 Reporting Rule Changes

The changes to the T-100 reporting system that occurred in October 2002 cannot be ignored, and their effects are most visible in analyses done in regards to time.

The most impactful aspect of the 2002 changes is the requirement of domestic all-cargo operations to report their flows. The freight flows before 2002 consisted primarily of air carriers which carried cargo in the hull beneath the passenger deck. This change caused a near doubling of freight flows between 2001 and 2003. Those megaregions which have freight hubs for UPS and FedEx are the most likely to see major jumps in freight traffic after 2002. There appears to be a transition period, as well, prior to the formal rule change; in 2001 a sharp rise in freight traffic occurs, which appeared abnormal. For the purpose of time series analysis, the data will be analyzed from 1990-2000, and then from 2003-2008, with the transition years of 2001 and 2002 skipped. In terms of comparisons of gross volumes of freight, it is likely that the megaregions that have high freight flows would be even further separated from megaregions with low freight flows. The results of the gross flow freight analysis will be reported without concern for the rule changes, and it will be acknowledged in the final remarks of this study that differences in freight flows likely would have been larger between megaregions with and without freight hubs. The rule change, however, does not affect international freight, as international all-cargo flights were always required to be reported. This part of the data can be reported without concern.

The effect of international carriers having to report their small passenger aircraft operations in addition to their large aircraft is less noticeable in the data than the freight rule change. When examining the international flow changes between 2001 and 2003, there is no abnormal jump in the dataset like there is with the domestic freight operations change. It is reasoned that the rule change for international carriers was minimal, as most carriers use large jets for passenger travel to international destinations. The most likely megaregions to feel these minor effects would be those most connected internationally (higher likelihood for any aircraft operating internationally, including small ones) and megaregions which have strong ties to Mexico, Canada, and the Caribbean (geographically close international markets that are more likely to be served with smaller aircraft). In addition, is difficult to point out which rises in flows were due to post-9/11 air travel growth, and which were results of the change.

Changes in regards to small certificated and commuter aircraft being required to start reporting in 2002 seem to be minimal in the dataset. These services do not make up a sizeable amount of air flows as compared to the larger passenger carriers. Intramega traffic is the most likely to be affected, but it is difficult to point out which rises in flows were due to post-9/11 air travel growth, and which were the result of the rule change.

Joint service operation rule changes do not affect this study. No consideration is given in this study to the operator of a flight, only the volumes that result from it.

3.2.2 Differences Between Airport and Flow Data Sources

There were discrepancies when comparing the T-100 list of airports and those in the NORTAD and NTAD lists. Of the 1,880 airports reported in the T-100 system, 624 are not included in the geographical NORTAD, and 584 are not listed in the more recent NTAD. This accounts for only around 29,000 origin-destination pairs within the T-100 database. Although being a relatively small percentage of the full dataset, this raised a concern over what types of airports were missing, and what magnitude of error these airports missing from the spatial data would cause.

There was additional concern due to the T-100 database and the NORTAD and NTAD using different airport codes; the former uses IATA while the latter uses FAA. Although major hub airports have the same IATA and FAA codes, minor airports sometimes have different codes due to discrepancies with other worldwide airports. For example, St. Augustine Airport in St. Augustine, Florida uses the FAA code SGJ. Due to another airport internationally using the code SGJ, which is assigned to Sagarai, Papua New Guinea, St. Augustine Airport's IATA code is UST.

It was noted that some of the airports that fail to show up in the spatial databases from the T-100 data were due to the differences in FAA and IATA codes. This created a matching failure when trying to attribute T-100 data spatially in GIS.

The NTAD airport list was used because it is a more current list of airports in the U.S. system.

3.2.3 Missing Airport Error Analysis

Two reasons for the T-100 airports to be missing in the spatial database were hypothesized. The first was that there was a mismatch with the FAA and IATA airport codes. The second hypothesis was that the missing airports are privately owned and not open to the public, but exist in the T-100 database because there was commercial and non-commercial service provided to these airports at some point in time.

To test this hypothesis, a sample of the airports not in the spatial dataset was examined. One of the reasons it seemed that airports were missing was due to changes in airport codes. In this analysis, airnav.com and travelmath.com were used as resources to verify airport coordinates and designation codes. In particular, airnav.com provides a list of airports that have changed IATA airport codes since 1995; around 1000 private and public airports are listed.

After examining the sample of missing airports, it appeared there were distinct cases as to the situation of an airport listed in the T-100 database not showing up in the spatial database.

Unlisted - Airport in T-100 database does not exist in spatial database, and would need to be added with spatial coordinates. Very likely is a private airport, and thus not listed in the spatial database. (e.g. A41 [IATA] Kogru River Airport, Kogru River, AK.)

Changed Airport Code - An airport exists in the T-100 database with one IATA code, and exists in the spatial database with a different airport code. At some point this airport changed its IATA code, and may or may not exist in the airnav.com list. (e.g. A66 [IATA], Hope Airport, is now 5HO [FAA].)

FAA/IATA mismatch – Some of the airports that appeared to have "Changed Airport Codes" in fact did not, and simply have an IATA code different from their FAA code. As noted before, an airport exists in the T-100 database with an IATA code, but in the spatial database, it is listed with an FAA code. (e.g. UST [IATA] and SGJ [FAA] for St. Augustine Airport, St. Augustine, FL.)

Switched Airport Code - An airport exists in the T-100 database with one IATA code, and exists in the spatial database with a different FAA code. A different airport now uses the former IATA code as its own. This change may or may not exist in the airnav.com list. (e.g. A69 [IATA], Cold Bay Airport, is now CDB [IATA, FAA]. A69 [FAA]now exists for a different airport, Tanis Mesa Airport, Yakutat, AK.)

<u>Stolen Airport Code</u> - An airport exists in the T-100 database with one IATA code, but does not exist in the spatial database. The FAA code equal to the IATA code exists for a different airport. (e.g. A51 [IATA], Wien Lake Airport, Wien Lake, AK does not exist in the spatial database. A51 [FAA] is a different airport, Costin Airport, Port St. Joe, FL.)

It was determined that classifying each of the 584 airports in the T-100 dataset that do not match with the NTAD into one of the above categories would not contribute significantly to the study. The total number of passengers and freight volumes accounted for by these 584 airports is no more than 0.30% of the total volume of all 1880 airports in the T-100 database. There would be little return on the time investment needed to classify the airports, with geo-location necessary for many.

It was felt after examining the missing airport data, however, that many of the largest missing airports by volume were the easiest case to adjust for: an FAA/IATA mismatch. These were considered worthwhile to manually adjust for, particularly because some significant minor airports within the continental U.S. that receive commercial service were on this list, including:

Marquette International Airport, Marquette, MI; MQT (IATA), SAW (FAA)

Hilton Head Airport, Hilton Head Island, SC; HHH (IATA), HXD (FAA)

University Park Airport, State College, PA; SCE (IATA), UNV (FAA)

McClellan-Palomar Airport, Carlsbad, CA; CLD (IATA), CRQ (FAA)

To correct for these airports with an FAA/IATA mismatch, it was decided to manually change the FAA codes in the spatial database for some significant airports to IATA codes. Significance was based on a volume cutoff. Any missing airport that had over 10,000 passengers or 1,000,000 pounds of freight in a given year was examined for an FAA/IATA mismatch. Twenty-six airports were identified using this process, including the four listed above, and are no longer mismatched. Ten of these airports were within megaregions, exemplifying the importance of going through this error checking process.

Lastly, amongst the missing airports, there were some easy fixes that could be made. For example, Colombia's flag carrier Avianca listed its origin and destination airport in New York City as an IATA code of "NYC". This does not correspond to any airport. A simple look on Avianca's website shows that the airline uses John F. Kennedy International Airport as a focus city for the region. Thus the error was corrected by changing the code "NYC" to "JFK" within the T-100 database. Another airport, Mena Intermountain Municipal Airport MEZ (FAA) has no IATA designation, thus was coded blank as "XXX" in the T-100 database. It was given the FAA designation for the purpose of this study.

It must be noted that some minor airports with significant volumes (above 10,000 passengers or 1,000,000 pounds of freight) were not in the NTAD list of airports. All of these were primarily used for freight movements. They were excluded from this analysis because no geolocating was performed to retain airports. The airports excluded were:

Hickam Air Force Base, Honolulu, HI; HIK (IATA)

Selief Bay Airport, Selief Bay, AK; A31 (IATA)

Ice Strip, Barrow, AK; A94 (IATA)

Barrow, AK; A96 (IATA)

Rantoul National Aviation Center, Rantoul, IL; II1 (IATA)

Donlin Creek Airport, Donlin Creek, AK; FVQ (IATA)

With the above changes, there are now 1,308 airports accounted for that can be linked between the T-100 database and the NTAD spatial database. Approximately 2,500 origin-destination pairs are now retained due to cleaning of the dataset. The result of this fix is a large reduction in missing volumes from the total due to missing airports in the spatial database. The remaining 569 airports account for 0.04% of passenger volumes and 0.08% of freight volumes. The volumes these amount to were considered to have minimal effects on the overall study conclusions.

The final product of this analysis is a T-100 database that only includes airports that are able to be spatially located with the NTAD. The NTAD itself has been trimmed to only include the airports in T-100, removing many public aviation facilities such as hospitals and general aviation airports. These airports are listed in Appendix A and were used in the analyses that follow. A map of each megaregion's airports in the dataset are shown in Figures C.1 through C.11.

3.2.4 Airport and Flow Megaregion Assignment

Using GIS, the NTAD airport list was spatially associated to the megaregion it was located within. Any airport not within any megaregion was assigned non-megaregion status. All non-megaregions airports are grouped together as one dataset for this study.

Using the airport list, with associated megaregions, each of the flows within the T-100 database was classified by their origin and destination in terms of megaregions. The only airports in the database that did not have a megaregion or non-megaregion label after the spatial locating of the NTAD airport list are international airports. Thus, when assigning origins and destinations, these airports label was "International".

With this assignment throughout the T-100 database, all flows were able to be classified as intra-megaregion flows, inter-megaregion flows, flows from megaregions to international and non-megaregion airports, and flows from non-megaregion airports to other non-megaregion and international airports. An origin-destination table for the T-100 database was then able to be created for analysis of megaregion travel.

3.2.5 Dual-Megaregion Designation

Within America 2050's set of megaregions, there is overlap between the Gulf Coast and Texas Triangle megaregions. This dual-megaregion designation covers the full region of the Houston Metropolitan area. The effect on this study is ten airports in the Houston region are designated as being in two megaregions, including George Bush

Intercontinental Airport (IAH) and William P. Hobby Airport (HOU). Within the tables summarizing air flows between megaregions, the movements between these ten airports and the rest of the airport network are credited towards both the Texas Triangle and Gulf Coast megaregion totals. Thus, the sum of all T-100 flows in the dataset is less than the sum of all the eleven megaregions and the non-megaregional areas, because the T-100 flows for the Houston airports are doubly attributed.

3.2.6 Standardizing Flows

The megaregions in this study range in size, having vastly different land areas, populations, and economies. Due to these differences, there are accordingly large differences in flows. In general, the larger megaregions have larger passenger and freight flows because they have the greater foundation on which to generate such flows. To provide fair comparison in the study, the analyses comprise both an examination of gross volumes and standardized flows. By comparing standardized flows, the megaregions can be examined on an equal basis. Two types of standardization are performed in this study: single megaregion standardization and market pair standardization.

Only megaregion and non-megaregion areas have standardized flows. The international market does not have measurable attributes to tie to the data. Rather than assume a land area, population, and economic production level for the combined set of airports in the international market, this part of the data was excluded from standardization.

To compare megaregions on their level of air activity, each megaregion's gross passenger and freight flows are standardized by its area, population, and economic productivity. The gross productions and gross attractions are individually divided by the three standardization characteristics associated with that megaregion. The calculation is as follows:

$$\frac{Production_{OD}\ (or\ Attraction_{DO})}{Area\ (or\ Population\ or\ Economic\ Productivity)}$$

Market pair standardization involved the flows between two megaregions. To calculate the standardized flow between two spaces, their combined standardization values were used within the denominator. Thus, the standardized flow by economic production between the Piedmont and the Texas Triangle would be divided by the summed size of both economies. The calculation for standardized market flows is:

$$\frac{Flow_{A\ to\ B} + \ Flow_{B\ to\ A}}{\begin{array}{c} Area_A + Area_B(or\ Population_A + \ Population_B \\ or\ Economic\ Productivity_A + \ Economic\ Productivity_B) \end{array}}$$

3.3 Analysis Procedure

Seven different analysis procedures were used to compare the role airports and aviation play in megaregions. Focus was on the megaregion's aviation infrastructure, the volume of flows of each megaregion, the market pairs of megaregions, the internal megaregion flows, the role of non-megaregion areas and the international market, and how aviation has grown in megaregions over time. The following sections discuss each analysis procedure.

3.3.1 Megaregion Airport Infrastructure

A comparison of the megaregion and non-megaregion areas' infrastructure was performed by looking at the concentration of airports within each. The number of airports for each area was determined by the number of airports in the T-100 database that are spatially located within the megaregion and non-megaregion areas. These totals were divided by the area, population, and GMP of each of the areas, as defined by America 2050 (America 2050, 2008). This normalization produced values for airport density, airports per capita, and number of airports with respect to economic productivity, respectively. These values were then compared across the different areas to determine which have the highest concentrations of airport infrastructure.

In order to compare the megaregions by the significance of the airport infrastructure within each area, the NPIAS classifications were assigned to each airport in the T-100 dataset. The megaregion and non-megaregion areas were compared by the number of primary airports within each. The varying levels of large, medium, small, and non-hub airports indicated which areas had more airports that play greater roles in the U.S. airport system.

The megaregion and non-megaregion areas were also compared by their role in the airline industry. A comparison was performed based on the degree to which each area is involved in airline hubbing activity. For the purpose of mapping the airline hubs, an airport was classified by the dominant hubbing activities for both passenger and freight airlines occurring at that airport. Only the passenger hub status that carried the most weight was used to characterize an airport, with the priority in order given by Passenger Hub, then Focus City, and finally Former Hub. For example, an airport which is a

Passenger Hub for one airline, a Focus City for a second airline, and a Former Hub for a third airline, would be characterized as a Passenger Hub. An airport that is a Focus City for one airline, and a Former Hub for another airline, would be characterized as a Focus City. From this procedure, six different airport types were seen occurring throughout the U.S.:

Passenger Hub

Freight Hub

Passenger/Freight Hub

Freight Hub/Focus City

Focus City

Former Hub

Each of the megaregion and non-megaregion areas had their number of airports with hub statuses tallied. The count was based on the six different airport types, such that only the weightiest hub status for passenger airlines was recorded for that airport. For example, a megaregion with two Passenger Hub airports, one Passenger/Freight Hub airport, one Freight Hub/Focus City airport, two Focus Cities, and one Former Hub would be given a count of three Passenger Hubs, two Freight Hubs, three Focus Cities, and one Former Hub. The airline hub characteristics of each area were compared based on the number and significance of hubs within that area.

3.3.2 Megaregion Air Traffic Volumes

The airport flows for the megaregion and non-megaregion areas were compared by the volume of passenger and freight flows occurring in and out of each area's airports. The volumes, already summed up at the megaregion level, were examined for each area by gross volume and normalized measures: by area, by population, and by economic productivity.

The comparison between the megaregions, non-megaregion areas, and a combined set of international airports was done for the gross volume of flows of passenger and freight traffic. A ranking was done to be able to discuss which areas are more involved in air travel. This is applicable because it shows which megaregions have more air activity, and thus are larger players in the overall network. To show differences based on activity that is fair based on the base characteristics of each area, rankings were done also on the normalized flows. The purpose is to see if some areas are more active in air travel based on the size of that area. For example, a small megaregion may not have much air activity, but for the number of people residing there, the population may fly more than the people in a larger megaregion.

3.3.3 Origin-Destination Megaregion Pairs

The origin-destination pairings of all the megaregions to each other, and to non-megaregion areas and the international market were compared. Each of the pairings were classified as either intramegaregional flows, those within a single megaregions; intermegaregional flows, those between megaregions; non-megaregional, those involving the non-megaregion areas; and international, those involving flights to and from international cities.

Flows were considered to be the traffic in both directions in a pairing, although directional flows are reported, and ranked based on this combination. Productions and attractions are not compared separately because flows in each direction, particularly for passenger flow, were similar. Freight flows more often differed by direction of flow in a pairing, and the difference is captured through a percentage difference, which was calculated as:

$$\text{Percent difference in directional flows} = \frac{(Flow_{A\ to\ B} - Flow_{B\ to\ A})}{(Flow_{A\ to\ B} + Flow_{B\ to\ A})/2} x\ 100\%$$

Combined flows were sorted from greatest to smallest, and the Top 20 passenger and freight movements between pairings were identified. These Top 20 are color coded by the type of flow (intramega, intermega, non-mega, international).

Standardized flows are also reported in this portion of the study. To standardize a directional flow between an OD pairing of megaregions or non-megaregion areas, a sum of the attributes of both parts of the pairing were used. For example, a flow from the Northeast to the Piedmont would be divided by the summed population of both megaregions. The standardized OD directional flows were summed for each direction, such that the combined standardized flow represented both directional flows of the market. This was done for population, area, and economic productivity. International flows were not included in the standardization portion of the analysis because no population, area, and economic productivity attributes were readily available. The combined flow pairings were ranked and the Top 20 are reported for both passenger and freight traffic.

3.3.4 Individual Megaregions: Origin-Destination Flows

Using the same methods of summing of flow pairings, standardizing flows, and comparing freight flow directional traffic, an analysis of each megaregion's air activity was performed. Each megaregion was individually discussed as to which areas they were most connected with among all the megaregions, non-megaregion areas, and the international market. For freight flows, the percent difference between the productions from and attractions to a given megaregion were compared to show which markets the megaregion was a net importer from or exporter to.

Standardized combined flow pairings were compared by area, population, and economic productivity from a given megaregion to all other megaregions and non-megaregion areas. The top three and bottom three connections were discussed.

3.3.5 Individual Megaregions: Intramega Flows

Analysis on the intramega flows of the megaregions allows an understanding on the processes occurring between the metropolitan areas within the megaregion. The spatial orientation of the airports within a megaregion is likely to have consequences on the level of intramega traffic.

For each megaregion, the passenger and freight traffic between airports within are mapped using GIS. The scale of flow lines between airports are kept consistent over the eleven megaregion passenger flow maps, similarly over the eleven freight flow maps.

This allows comparison between the megaregions in terms of magnitudes of flows occurring within the megaregions. In addition, the proportional difference between the colored flow lines are the same between passenger and freight maps. For example, the proportion between a yellow and red line on the passenger maps, is the same as the proportion between a yellow and red line on the freight maps.

Each megaregion's spatial form of airport flows was classified into categories based on where the strongest connections are within the megaregion. Megaregions in which all metropolitan areas had a focus on one major metropolitan area's airports were termed hub-focused. Those which had a strong pairing between two metropolitan areas with all other airports mainly travelling between one of these two were termed a dyad, while those with three main foci of activity were termed tri-poles. The fourth classification was galactic, where there were many foci of activity, and not all airports were significantly connected to all other major airports, and minor airports had an array of roles with more flows between each other.

3.3.6 Non-megaregion Areas and the International Market

Similar to how megaregions are evaluated, the flow pairs with non-megaregion areas and the international market are each analyzed to determine which megaregions are most connected. For freight flows, the percent difference between the productions from and attractions to a given megaregion were compared to show which markets the megaregion was a net importer from or exporter to.

Standardized combined flow pairings were compared by area, population, and economic productivity to all the megaregions and with non-megaregion areas. The top three and bottom three connections were discussed.

3.3.7 Growth of a Megaregion's Air Traffic

Capturing the differences in how air traffic has changed over time required the compilation of the T-100 OD pairs by year. Each individual flow in the database was classified by the flow types used throughout the study: intramega, intermega, non-mega, and international. In addition, this part of the study has a fifth type of flow for the flows between non-megaregion area airports. This flow was termed internal non-mega.

A time series analysis was performed over the 1990-2008 study period, plotting the growth of the flows over time. The total of all flows was also plotted. This comparison allows the visualization of how air traffic between the areas in the study changed during the shifting market dynamics of the two decades being studied.

To compare the relative growth of each type of movement, each of the flows were referenced to their level of activity in 1990. With this method, reading any referenced flow in any year is an indication of the change in volume since 1990. For example, a referenced intermega flow in 2006 of 2.5 means the intermega flows of that year were two and a half times larger than they were in 1990. These referenced flows were plotted against time along with the nation's GDP, adjusted for inflation, and the national population. These values were those compiled by the Budget of the U.S. Government and the U.S. Census Population Estimates, respectively. In doing this comparison, it is possible to tell which flows grew faster respective to others over the same time period. In addition, it was possible to be seen how the aviation market compared against national population and economic measures.

Intramega flows received extra attention in the time series analysis. Each megaregion's intramega flows were analyzed over time to see their growth patterns. Their flows were referenced to 1990, and compared against one another.

A case study was also performed for the Piedmont megaregion. The focus of this case study was to examine where flows were heading in the megaregion over time in regards to the NPIAS hub status. The hub statuses were arranged into three groups: large hub primary airports; medium, small, and non-hub primary airports; and non-primary airports. The flows between each of these categories were calculated for each year in the study period, creating six different flow profiles. These were then compared against each other for total volume and relative growth over time in both the passenger and freight sectors.

Passenger and freight flows were compared separately. As discussed earlier, the T-100 reporting rule changes affected freight flows more significantly than passenger flows. Thus, it was decided not to include the transition years of 2001 and 2002 in the time series analysis, except for international freight flows which were not affected by the rule changes. Therefore, referenced freight flow analyses are plotted with a gap in 2001 and 2002. Flows 2000 and prior are referenced to 1990. Flows from 2003-2008 are referenced to 2003, because their magnitudes are many times larger than those prior to 2000 due to the rule changes.

CHAPTER 4

RESULTS

This study's results are broken down into six sections, examining airports and air travel in the context of megaregions through different criteria.

The first discussion is on airport infrastructure as it relates to megaregions. The megaregions and the non-megaregion areas are compared by the airports that are within them and how this relates to area, population, airlines, and economic productivity.

The second discussion is a comparison of megaregions as origins and destinations that attract and produce passenger and freight flows. The flows are standardized by area, population, and economic productivity to compare the relative proclivity of megaregions to be involved in the two different sectors.

An analysis on the flows between pairs of megaregions, non-megaregion areas, and the international market makes up the third discussion. The Top 20 passenger and freight flows are reported by gross volume, and standardized by area, population, and economic productivity. The goal is to see where in the U.S. the most active air traffic flows exist.

An individual examination of each megaregion's flow pairs is conducted in the fourth discussion. For each megaregion, its passenger and flow pairs to other megaregions, non-megaregion areas, and internationally are compared by gross volume and standardization of volumes by area, population, and economic productivity. This analysis provides insight into which megaregions are most closely connected.

The fifth discussion is on the intramega flows of each megaregion. Maps of each megaregion's airports show the passenger and freight traffic occurring between them. An examination of the spatial relationships between the airports and the significance of the flows is used to draw conclusions as to how a megaregion's metropolitan areas interact through air travel.

The sixth discussion focuses on non-megaregion areas and the international market. It is similar to the discussion on each megaregion, but with a goal to gain a better understanding of how these areas themselves relate to the megaregions.

The seventh discussion brings in the element of time for passenger and freight flow growth. Comparison of intermega, intramega, non-mega, internal non-mega, and international flows is done against the population and economy of the U.S. The goal is to see how fast each of these types of flows has grown compared to each other by magnitude and rate. The intramega flows of each megaregion are compared to see how they have changed over time. Lastly, a case study is done on the Piedmont megaregion, to see how its internal airports' flows have shifted over time.

4.1 Megaregion Airport Infrastructure

The airport system in the United States, as defined in this study to be the airports listed both in the NTAD and T-100 database, consists of 1308 airports. Within megaregions airport infrastructure occurs at much higher concentrations. Similar to road, rail, and communication networks, which are found in dense networks, large airports with high activity are generally found in U.S. megaregions. This is not surprising in that megaregions are the focus of the U.S. population and economic activity, and the majority of transport activity and infrastructure exists within the eleven megaregions.

In the following section, megaregion and the non-megaregion areas are compared by the density of airports, the number of airports per capita, and the number of airports with respect to economic productivity. In addition, the sizes of the airports within the different megaregions are compared to see which have intensely built up airport infrastructure. Lastly, the megaregions are compared by the number of airline hubs that exist, as a measure of impact within the air industry.

4.1.1 Airport Density

Megaregions have higher densities of airports within their land area than non-megaregional areas, even though there are more airports located throughout non-megaregional areas (61% of U.S. airports exist in non-megaregional areas). This high level of airports in non-megaregional areas though, is primarily due to the sheer size of the remainder of the country, as non-megaregional space makes up 74% of the U.S. Thus megaregions, which encompass only 26% of land area, have 39% of the airports. To provide air service to the population throughout the country, airports are located even in otherwise remote spaces, but in megaregions they exist in higher density.

The megaregions' larger concentration of airports indicates better access to air travel for megaregional populations. In most cases, each megaregion's airport density is much higher than the national average of 4.3 airports per 10,000 square miles. Megaregions on average have a density of 6.6 airports per 10,000 square miles as compared to non-megaregions at 3.5 airports per 10,000 square miles. All but three megaregions have higher densities than the national average, as seen in Table 4.1, with the highest being the Northeast megaregion at 14.0 per 10,000 square miles, and Southern Florida in second with 11.9. This corresponds appropriately to their high population densities, as these two megaregions are the top two in people per square mile. The desert and mountainous megaregions, however, do stand out as exceptions. The Arizona Sun Corridor, Front Range, and Texas Triangle megaregions all have lower airport densities than the national average. This indicates that their airport infrastructure is concentrated around the major metropolitan areas with fewer airports in between. Figure 4.1 shows the national spatial distribution of airports in the U.S., and it is clear that these three megaregions have a lower intensity of airport concentration.

Table 4.1 Megaregion Airports by Area and Population

Megaregion	Number of Airports in T-100 and NTAD	Airport Density (per 10,000 sq miles)	Airports per capita (per million persons)
Arizona Sun Corridor	16	3.3	3.5
Cascadia	25	5.3	3.4
Front Range	12	2.1	2.5
Gulf Coast	36	6.2	3.1
Midwest	138	6.7	2.6
Northeast	86	14.0	1.7
Northern California	35	7.3	2.8
Piedmont	43	7.2	2.9
Southern California	48	7.8	2.2
Southern Florida	46	11.9	3.1
Texas Triangle	36	4.2	2.2
Megaregions	511	6.6	2.5
Rest of Country	797	3.5	10.8
United States	1308	4.3	4.7
Megaregion Percent	39%	n/a	n/a

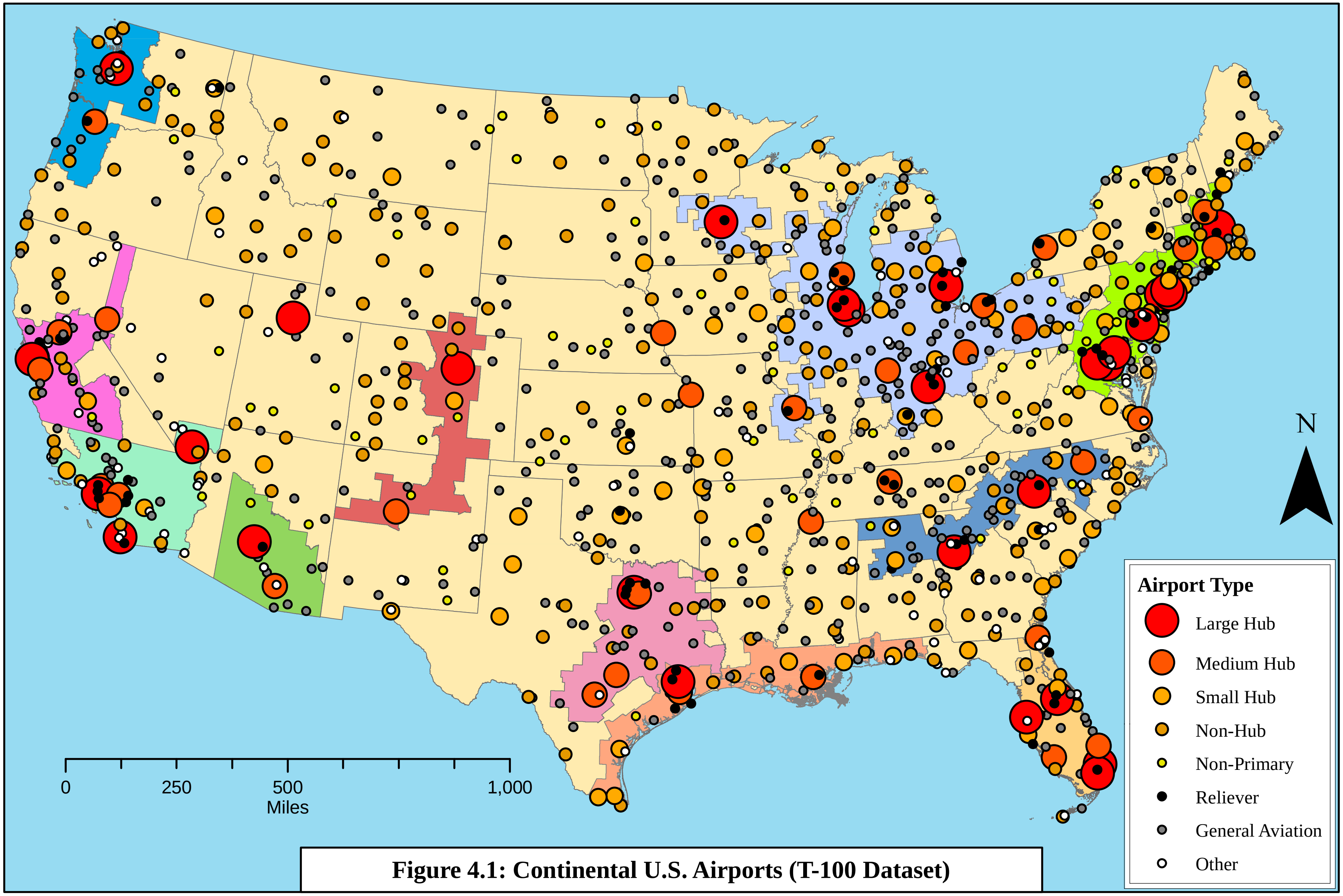

Figure 4.1: Continental U.S. Airports (T-100 Dataset)

4.1.2 Airports per Capita

The megaregions have a sharp difference in the number of airports for their respective populations as compared to non-megaregional areas. This is verified when examining the airports per capita, seen in Table 4.1; in non-megaregion areas there are more airports per million persons than in megaregions, 10.8 for the former compared to 2.5 for the latter. Although megaregions have higher densities of airports, there are fewer airports to serve the respective populations. With five times as many airports for its population, non-megaregion areas' need for air service for passenger and cargo movements is directly related to the larger areas served. Despite its large spread of where people and businesses are located, airports still must exist to provide the infrastructure for air travel.

The Northeast has the fewest airports per capita with 1.7 airports per million persons, a reflection of larger populations and population densities in the Northeast. This measure potentially reflects the higher air congestion levels in this megaregion. Southern California and the Texas Triangle have the second lowest number of airports per capita. The Arizona Sun Corridor, Cascadia, Gulf Coast, and Southern Florida all have airports per capita that are higher than three per million persons, but still are less than the national average of 4.7 per million persons.

4.1.3 Airports and Economic Production

Megaregions' economic production as measured in GMP is much higher than that for other parts of the U.S. Nationally, there are 10.5 airports for every $100 billion of GDP. There is a clear distinction between megaregions and non-megaregion areas as seen in Table 4.2. Megaregions on average have 5.5 airports for every $100 billion of GMP, while non-megaregions have 24.6. This difference is indicative of the more intense concentration of economic activity in megaregions. Airports in megaregions are more likely to have a larger role in the economy than airports outside megaregions.

Table 4.2: Megaregion Airports and Economic Production

Megaregion	**Airports per $100 Billion GMP**
Arizona Sun Corridor	8.4
Cascadia	7.4
Front Range	5.2
Gulf Coast	6.9
Midwest	6.7
Northeast	3.3
Northern California	5.6
Piedmont	8.8
Southern California	4.6
Southern Florida	7.6
Texas Triangle	4.4
Megaregions	5.6
Rest of Country	24.6
United States	10.5
Megaregion Percent	n/a

The top three megaregions in terms of number of airports by economic production are the same as those as airports per capita. The Northeast has 3.3 airports per $100 billion of GMP, the Texas Triangle 4.4, and Southern California 4.6. These megaregions' airports are tied to a larger economic output as compared to other megaregions. The lagging megaregions are the Piedmont megaregion with 8.8 airports per $100 billion of

GMP, and the Arizona Sun Corridor with 8.4, although both are still in a better position than the national average.

4.1.4 Hub Airports

Hub airports can be defined in two ways: a descriptive FAA measurement of activity at an airport or an airport that functions as the hub in a hub-and-spoke network for an airline. Both usages of the term “hub” are discussed in terms of megaregions in the following section.

4.1.4.1 FAA Hubs

The definition of hubs under FAA terminology is used to determine funding for federal programs, and is defined by the level of annual passenger activity at an airport. Primary airports handle at least 10,000 passengers per year. Of these, large hubs handle at least 1% of all annual U.S. passenger movements, medium hubs between 0.25 and 1%, small hubs between 0.05 and 0.25%, and non-hubs above 10,000 but less than 0.05%. Airports in NPIAS that have less than 10,000 annual passengers, but greater than 2,500 annual passengers are classified as non-primary airports. General aviation airports handle fewer than 2,500 passenger each year, and are the smallest category. Reliever airports are general aviation airports that can be used to relieve large primary airports when necessary. All of these airport categories are displayed in Figure 4.1 to show the distribution of hub airports throughout the U.S. In Table 4.3, each megaregion is listed with the types and number of FAA hubs that are within the megaregion. Primary, non-primary, reliever, and general aviation airports are only located on the map and included in the analysis if they had T-100 data associated with them in the last eighteen years, so

Figure 4.1 is not a map of all airport facilities in the nation, only those that had passenger or freight movements reported to the FAA through the T-100 form.

Table 4.3: Megaregion FAA Airport Hubs

	Hubs					
Megaregion	**Large**	**Medium**	**Small**	**Non-hub**	**Total Primary**	**% Primary**
Arizona Sun Corridor	1	1	0	0	2	12.5%
Cascadia	1	1	0	6	8	32.0%
Front Range	1	1	1	3	6	50.0%
Gulf Coast	1	2	6	7	16	44.4%
Midwest	5	6	10	25	46	33.3%
Northeast	8	3	5	13	29	33.7%
Northern California	1	4	1	3	9	25.7%
Piedmont	2	1	4	2	9	20.9%
Southern California	3	3	3	8	17	35.4%
Southern Florida	4	3	2	7	16	34.8%
Texas Triangle	2	4	0	6	12	33.3%
Megaregions	28	28	32	79	167	32.7%
Rest of Country	2	9	40	158	209	26.2%
United States	30	37	72	237	376	28.7%
Megaregion Percent	93%	76%	44%	33%	44%	n/a

Major airports are more often found in megaregions than elsewhere. Within megaregions, hub airports make up almost one third of all megaregion airports, but only just over a quarter in nonmegaregion areas. Despite having only 39% of all U.S. airports on 26% of U.S. land area, megaregions have 44% of all primary airports. Of these, the majority of large hubs and medium hubs are found in megaregions, 93% and 76%, respectively. Non-megaregions altogether have only two large hub airports. The megaregions are the locations of the country's largest economic engines, and large airports are part of the conglomeration to support such strong growth.

Individually, megaregions have different distributions of primary airports. All megaregions have at least one large hub and one medium hub airport. All but the Arizona Sun Corridor has a large number of non-hub primary airports, and this FAA group is often the largest of all the categories for a given megaregion. The Midwest megaregion has the most primary airports – 46 – due mainly to its large size, five of which are large hubs. The Northeast, although second with 29 primary airports, has the largest number of large hubs with eight. The Southern California, Gulf Coast, and Southern Florida megaregions are the next highest in the number of primary airports. The Arizona Sun Corridor only has two primary airports, and lags behind all other megaregions in terms of hub airport infrastructure.

4.1.4.2 Airline Hubs

U.S. legacy airlines are characterized by extensive hub-and-spoke networks, with airline hubs having been established nationwide. Even low cost airlines have focus cities that have higher levels of activity and transfers of passengers. Freight airlines also have hubs built to focus where goods are transferred between airplanes. Megaregions are often the choice place to locate airline hubs because airports there are often larger, have a higher propensity for international passengers, and are located near major metropolitan areas which have the talent pool necessary for the corporate management and maintenance of an airline and its airplanes. The level of airline hubbing activity in a megaregion is indicative of the role that a megaregion plays in the U.S. aviation industry.

Each of the megaregions has airports that play strong roles in U.S. airlines' hubbing activities. Within each megaregion, at least one of the major U.S. airlines, those listed in Tables MZ-1 and MZ-2, has located a hub in one airport. Table 4.4 describes the different hub situations during the 1990-2008 time period. A map of the airline hubs as they relate to U.S. megaregions is displayed in Figure 4.2. A corresponding list which details which airlines operate as hubs at U.S. airports is found in Table A.2.

Table 4.4: Megaregion Airline Hubs

	Airline Hubs			
Megaregion	**Passenger Hub**	**Focus City**	**Former Hub**	**Freight Hub**
Arizona Sun Corridor	1	0	0	0
Cascadia	2	0	0	0
Front Range	1	0	0	0
Gulf Coast	1	1	0	0
Midwest	6	2	3	3
Northeast	4	4	0	3
Northern California	1	1	1	1
Piedmont	2	0	2	0
Southern California	1	2	0	1
Southern Florida	2	3	0	1
Texas Triangle	2	2	0	2
Megaregions	23	15	6	11
Rest of Country	3	0	2	3
United States	26	15	8	14
Megaregion Percent	88%	100%	75%	79%

The megaregions have a much stronger presence in airline hub operations than non-megaregion areas with 88% of all current passenger hubs, 100% of all focus cities, and 79% of freight hubs existing in megaregions. Even of the airports that used to have a

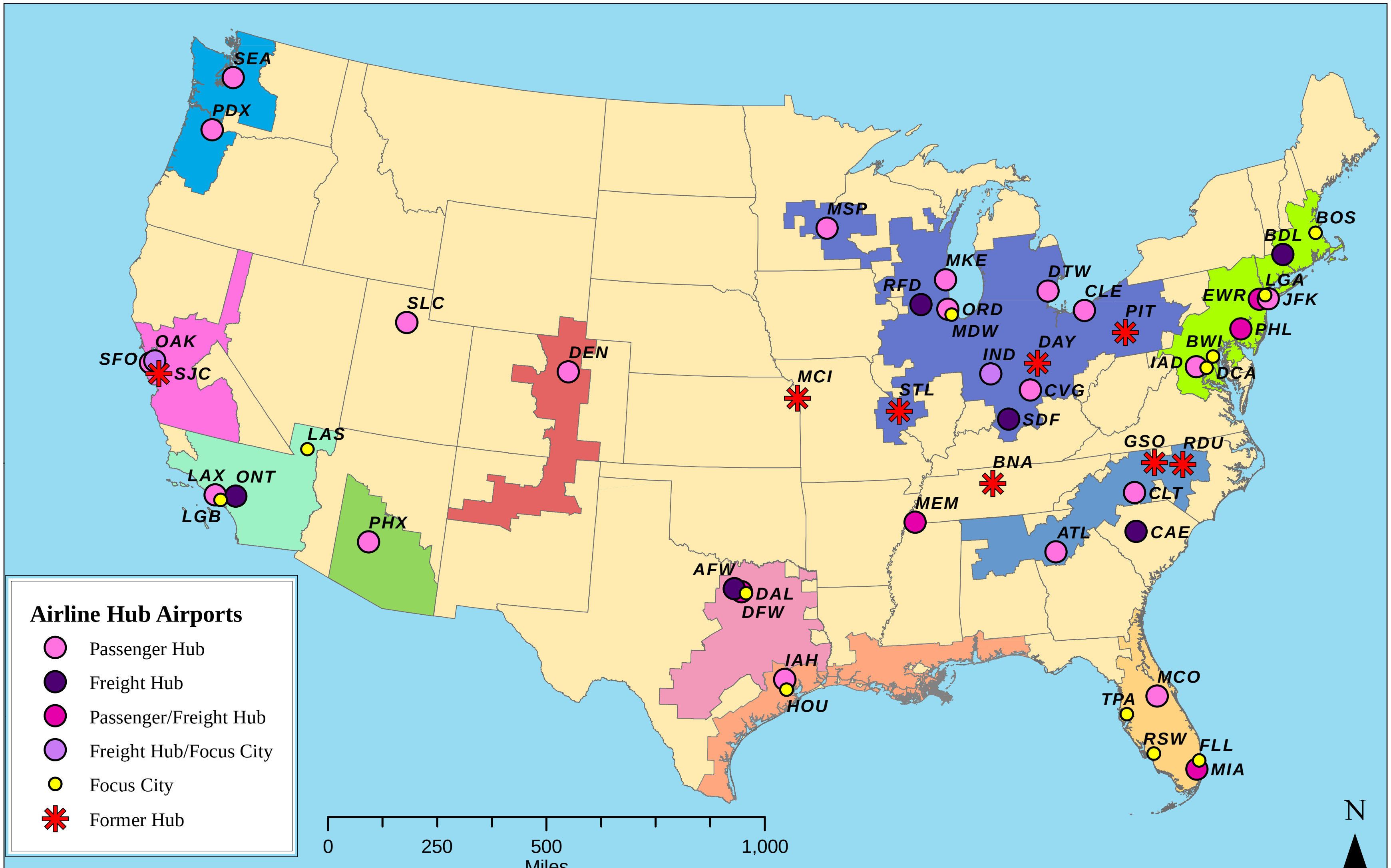

Figure 4.2: Continental U.S. Airline Hubs for Passenger and Freight

hub, but currently do not, 75% are located in megaregions. Megaregion's airports play prominent roles in airlines' shaping of their route structure.

Of the megaregions, the ones with the most number of FAA designated large hub airports also have the most airline hubs. The Midwest leads the megaregions with six of its airports serving as passenger hubs for airlines, two airports serving as focus cities for airlines, and three airports serving roles as freight hubs. In addition, three airports used to have hubbing operations for airlines have now moved elsewhere. The Northeast is in second with four airports serving as airline hubs, but also as four airports serving as focus cities for airlines. Three of its airports serve as freight hubs. The Arizona Sun Corridor has the least number of airline hubs, with only PHX serving as a passenger hub.

Southern Florida and the Northeast stand out in the area of focus cities. The geographic fact that these megaregions are in the corners of the nation, causes them to be less desirable to have hubbing because they are not in suitable operational locations. They do, however, have many focus cities because airlines recognize the importance of these airports and their respective associated economies, and focus some part of their operations there.

The Piedmont megaregion stands out because of the number of former hubs it has in relation to the number of hubs it currently has. Although the Midwest has three former hubs, this must be compared to the large number it has now and thus a higher likelihood of hubs closing. The Piedmont, however, only has two hubs currently in ATL and CLT, and no focus cities or freight hubs. During the study period, both GSO and RDU terminated hubbing operations from two airlines that are still in business.

4.1.5 Summary

It is evident that megaregions have a larger concentration of airports, especially significant airports, than the non-megaregion areas. There are more airports per square mile and a larger portion of those airports are primary hubs, with the largest hubs being almost entirely found in megaregions. Although there are more airports total in non-megaregion areas, they are more frequently smaller airport facilities serving areas that require air service. Thus, it was seen that non-megaregion airports serve smaller groups of people with more airports per capita. Lastly, megaregions are more likely to be the location of airline hubs over non-megaregions.

Amongst the megaregions, there is certainly a difference between how involved a megaregion is in air travel. The megaregions with greatest density of airports also have the greatest population densities. The opposite statement is true as well, as the least densely populated megaregions have the lower airport densities, even less than the non-megaregion areas. Megaregions with larger economies have less airports per dollars produced, but use their airports more intensely as they have less airports per person. The megaregions with the largest size and population have the most airline hubs and focus cities, but it is worthy to note that all megaregions have been picked by at least one airline to have a hub located there, so each megaregion is connected to some extensive set of direct flights.

4.2 Megaregion Air Traffic Volumes

The megaregions' level of air traffic for passenger and freight differs by each individual megaregion's characteristics. There is no leading megaregion in air travel that is at the top in all measures of comparison. The following section looks at passenger and freight movements in air travel for the eleven megaregions, non-megaregion areas, and international travel (when applicable).

In all cases, production and attraction numbers for air travel are displayed for future researchers' reference, but note that in almost all cases the ranked order is the same. Thus, for purposes of discussion, productions and attractions are not discussed separately, but grouped together and discussed generally as "trips" for passenger travel and "freight" for pounds of freight.

4.2.1 Gross Volume of Movements

The following section is an examination of the flows from the T-100 database for all airports grouped into their respective megaregions or other spatial designations. The flows are from 1990-2008 and include all reported traffic during that time period.

4.2.1.1 Passenger Traffic

The rankings of air passenger traffic is very similar to the ranking of megaregions by their population. The two most populated megaregions, the Midwest and the Northeast, are at the top of the list with 2.2 and 1.8 billion trips, respectively, as seen in Table 4.5. The remaining megaregions, on the list below non-megaregion and international areas, are also primarily in order of the size of population. The only difference is the Front Range, which has 20% more trips than Cascadia, although the latter has a population over 50% larger. The Arizona Sun Corridor has the least number of trips over the time period with about 340 million.

Table 4.5 Gross Megaregion Passenger Traffic

Megaregion	Trip Production	Trip Attraction
Midwest	2233497386	2239355676
Northeast	1840514962	1845850850
Non-mega	1617237390	1615271512
International	1198777893	1193178218
Southern California	1157679445	1152812968
Texas Triangle	1089282639	1089894952
Piedmont	1019510758	1021264596
Southern Florida	993392663	993517695
Northern California	634415224	635026425
Gulf Coast	522938954	522675907
Front Range	422009364	421850979
Cascadia	352658147	353251964
Arizona Sun Corridor	342359014	340322097

The non-megaregion areas, despite have a larger population, economy, and size than any of the individual megaregions does not top the list for number of trips. It is interesting to note that there is less passenger travel to and from non-megaregion areas than megaregions. This is likely due to a less dense concentration of population and economic activity.

International origins and destinations falls fourth on the list of gross passenger volume, just ahead of Southern California. As international travel only accounts for travel to and from the U.S., it is significant to note that this sector of the air industry is as large as the most active megaregions in terms of air traffic.

4.2.1.2 Freight Traffic

Air freight is strongly associated with international and non-megaregion areas, as these two spatial locations are at the top of the freight traffic volume rankings. International freight is very significant in the U.S. air system, accounting for more than the next two spatial areas combined, as seen in Table 4.6. Although shipping and trucking (from Canada and Mexico) are still significant portions of the international freight transportation industry, air transportation is still an important means for goods to find their way to the U.S.

Table 4.6: Gross Megaregion Freight Movements

Megaregion	Freight Production (lbs)	Freight Attraction (lbs)	% Diff.
International	149055487830	119762786769	-24.5%
Non-mega	67716165918	71690064963	5.5%
Midwest	67107936434	69755512106	3.8%
Northeast	51214365318	62305515009	17.8%
Southern Florida	33059915447	36671690741	9.8%
Southern California	32349299365	36127652823	10.5%
Northern California	17174119559	17612612694	2.5%
Texas Triangle	16492881128	17475940429	5.6%
Piedmont	13693499432	15355998769	10.8%
Cascadia	7965617308	7678087151	-3.7%
Gulf Coast	6424920968	6350158174	-1.2%
Front Range	3779691569	4738578159	20.2%
Arizona Sun Corridor	2671148588	3180451077	16.0%

There was a significant difference between productions and attractions for the megaregions, international, and non-megaregion areas. Table 4.6 shows the percent difference between what was produced and attracted to a given area. It is noticeable that the U.S. as a whole imports more goods through air freight than it exports. Thus, there is a 25% difference between international freight production and attraction, with more goods coming from overseas than being sent back by airplane. This difference in international air exports and imports is seen all the way down through the list; all but two of the megaregions and the non-megaregion areas have slightly larger freight attractions than freight productions. The Front Range, Northeast, and Arizona Sun Corridor megaregions have the highest rates of importing, with 20.2%, 17.8%, and 16.0%, respectively. The two megaregions that produce more than they attract, Cascadia and Gulf Coast, stand out among the rest by producing 3.7% and 1.2% more than they attract, respectively.

The combined non-megaregion areas have the second highest level of freight flows. This is indicative of the need of the populations to ship and receive goods to what are more isolated areas. Because of the sheer size of the non-megaregion areas, it is possible that for many populations, air freight is the most efficient way to transport goods.

Comparing the overall volume of freight movements, three megaregions stand out as being higher ranked as compared to megaregional population. Southern Florida is sixth in terms of population yet is third of all the megaregions in terms of freight movements. Northern California is seventh in population and fifth out of the megaregions for freight. Cascadia also moves slightly up the list in terms of freight movements, jumping over the Gulf Coast which has a higher population. In all, it seems the coastal megaregions are more involved in attracting and producing air freight than the mid-continental megaregions, likely because they are the major entry and exit points for international goods.

4.2.2 Movements Standardized by Area

In the following section, the flows in Tables 4.5 and 4.6 are standardized by the megaregions' respective land area. In this part of the study, international movements are excluded, because there is no suitable way to represent the area of the regions in which freight travels to and from internationally.

4.2.2.1 Passenger Traffic

The most significant result from the comparison of passenger traffic per square mile is the insignificant amount of travel from the non-megaregion areas. As seen in Table 4.7, with just over 700 passenger trips per square mile over the study period, the non-megaregion areas have an order of magnitude difference when compared to all megaregions. It is clear that the non-megaregion populations have a much lower propensity to engage in air travel than megaregion populations for the size of the area it encompasses.

Table 4.7: Megaregion Passenger Traffic by Land Area

Megaregion	Trip Production/ Sq mi	Trip Attraction/ Sq mi
Northeast	29862	29949
Southern Florida	25613	25617
Southern California	18713	18634
Piedmont	17111	17140
Northern California	13170	13182
Texas Triangle	12850	12857
Midwest	10893	10922
Gulf Coast	9042	9038
Cascadia	7449	7462
Front Range	7439	7436
Arizona Sun Corridor	7014	6973
Non-mega	720	719
International	n/a	n/a

The Northeast megaregion has the largest number of trips for its size, with nearly 30,000 trips per square mile. The Northeast is not nearly the smallest megaregion, but still has very high levels of passenger travel for its size. Southern Florida is second on the list, but also is the smallest of all the megaregions so there is a better opportunity for more travel for its size. Southern California is third on the list despite being third in size as well. The largest megaregion in size, the Midwest, is seventh in terms of trips per square mile. The Front Range and the Arizona Sun Corridor are at the bottom of the list of all megaregions by passenger traffic per square mile.

4.2.2.2 Freight Traffic

By land area, the non-megaregion areas again have the lowest volume of freight movements. The ranking of all the spaces is shown in Table 4.8. The difference, though, is not as large as it is with passenger travel, and is in the same order of magnitude. Despite being at the top of gross flows, non-megaregion areas cover large areas, and are not involved as heavily per square mile as the megaregions.

Southern Florida and the Northeast have the greatest amount of freight flows by land area. These two megaregions, for their size, are very heavily involved in freight. Their roles as international gateways likely have a strong effect in putting them at the top of the list. These are followed by the two California megaregions. The largest megaregion, the Midwest, is in fifth for freight volumes by land area. At the bottom of the rankings, just over twice as much freight flows than the non-megaregion areas, is the Arizona Sun Corridor.

Table 4.8: Megaregion Freight Movements by Land Area

Megaregion	Freight Production (lbs) / Sq mi	Freight Attraction (lbs) / Sq mi
Southern Florida	852411	945537
Northeast	830943	1010895
Southern California	522901	583976
Northern California	356517	365619
Midwest	327305	340218
Piedmont	229826	257729
Texas Triangle	194565	206162
Cascadia	168260	162187
Gulf Coast	111092	109800
Front Range	66625	83527
Arizona Sun Corridor	54727	65161
Non-mega	30158	31928
International	n/a	n/a

4.2.3 Movements Standardized by Population

The standardization by population for megaregions gives a perspective as to which megaregions' populations travel more and ship more goods. The following section is a comparison of the data from Tables 4.5 and 4.6 divided by the population. International flows are not included because there is not a standard population base for these origins and destinations.

4.2.3.1 Passenger Traffic

The top megaregions with volumes standardized by population are those which are more isolated and landlocked in the center of the country. With a small population, but one which is active in air travel, the Front Range leads all the megaregions in trips per person. Due perhaps to its isolation in the center of the country, the Front Range has around 14 more trips per person than the second place Arizona Sun Corridor, as seen in Table 4.9.

The Arizona Sun Corridor is the least populated megaregion, but like the Front Range, is more isolated than other megaregions by non-megaregion areas around it. Also near the top of the list is the Piedmont megaregion, a middle of the pack megaregion in terms of population, but a higher propensity for that population to travel.

Table 4.9: Megaregion Passenger Traffic by Population

Megaregion	Trip Production/ Person	Trip Attraction/ Person
Front Range	89.2	89.1
Arizona Sun Corridor	75.5	75.0
Piedmont	68.6	68.7
Southern Florida	67.6	67.6
Texas Triangle	67.5	67.6
Southern California	53.0	52.7
Northern California	49.9	49.9
Cascadia	47.7	47.7
Gulf Coast	44.5	44.5
Midwest	41.5	41.6
Northeast	37.1	37.2
Non-mega	22.0	22.0
International	n/a	n/a

The areas with the largest populations have the least number of trips per person. The Northeast and Midwest are at the bottom of all the megaregions just above non-megaregion areas. These three are in the top three in population, yet there is less propensity to travel by air for those residing there.

4.2.3.2 Freight Traffic

Southern Florida tops the list with the most freight trips per person, far above other megaregions, as seen in Table 4.10. This is indicative that the Southern Florida megaregion is a major entry and exit point for goods by air, likely occurring because of its strong Latin American connection. The two California megaregions are in second and third for freight per person. The Midwest is the only megaregion of the top half of the rankings that is not on one of the coasts. The Gulf Coast has the least amount of air freight per person, just below the Arizona Sun Corridor.

Table 4.10: Megaregion Freight Movements by Population

Megaregion	Freight Production (lbs) / Person	Freight Attraction (lbs) / Person
Southern Florida	2251	2497
Southern California	1480	1653
Northern California	1350	1384
Midwest	1248	1297
Cascadia	1076	1038
Northeast	1033	1257
Texas Triangle	1022	1083
Piedmont	922	1034
Non-mega	921	975
Front Range	798	1001
Arizona Sun Corridor	589	701
Gulf Coast	547	541
International	n/a	n/a

4.2.4 Movements Standardized by Economic Production

Ranking the megaregions by their air flows in terms of economic production is discussed in this section. The GMP of each megaregion is used to standardize the flows shown in Tables 4.6 and 4.6. International economies are not combined to standardize the international flows, so these passenger and freight movements are excluded.

4.2.4.1 Passenger Traffic

Although it has the largest economic contribution in the country, more than all the megaregions, the non-megaregion areas are last in terms of trips per billions of dollars of GMP. Similarly, the Northeast megaregion with the second largest economy in the U.S. is just ahead of the non-megaregion areas. The full rankings are shown in Table 4.11.

Table 4.11: Megaregion Passenger Traffic by Economic Productivity

Megaregion	Trip Production/ $ Billion GMP	Trip Attraction/ $ Billion GMP
Piedmont	2097759	2101367
Front Range	1842836	1842144
Arizona Sun Corridor	1792456	1781791
Southern Florida	1633870	1634075
Texas Triangle	1331641	1332390
Southern California	1116374	1111681
Midwest	1077423	1080249
Cascadia	1046463	1048225
Northern California	1018323	1019304
Gulf Coast	997975	997473
Northeast	710349	712409
Non-mega	499919	499311
International	n/a	n/a

The megaregions with the most trips per billions of dollars of GMP are similar to those with the most trips per person. The Piedmont megaregion is at the top of the rankings, with the Front Range in second, and the Arizona Sun Corridor. Each of these economies is less than 25% of the economies of the larger megaregions, but their populations travel much more often for the level of economic output of the region.

4.2.4.2 Freight Traffic

Freight movement is closely tied to the size of an economy, and Southern Florida is a much larger producer of freight trips per billion dollars of GMP than all the other megaregions. The Midwest and Southern California megaregion, the second and third largest of the megaregion economies, each have a standardized flow rate that is less than 60% that of Southern Florida, as seen in Table 4.12.

Table 4.12: Megaregion Freight Movements by Economic Productivity

Megaregion	Freight Production (lbs)/ $ Billion GMP	Freight Attraction (lbs)/ $ Billion GMP
Southern Florida	54374861	60315281
Midwest	32372376	33649548
Southern California	31195081	34838624
Piedmont	28175925	31596705
Northern California	27566805	28270646
Cascadia	23636847	22783641
Non-mega	20932354	22160762
Texas Triangle	20162446	21364230
Northeast	19766254	24046899
Front Range	16505203	20692481
Arizona Sun Corridor	13985071	16651576
Gulf Coast	12261300	12118622
International	n/a	n/a

The non-megaregions are higher up on this list than any other previous standardized freight list. This indicates that even with its overall large economic contribution, it is still very active in the movement of freight. The bottom of the list is similar to other freight standardized freight lists, with the Gulf Coast taking the bottom spot, and the Arizona Sun Corridor and the Front Range megaregions just ahead.

4.2.5 Summary

Comparing megaregions by their passenger travel is almost as simple as ordering them in terms of the size of their populations. It appears that the larger a population is the higher volume of passenger flow occurs. Non-megaregion areas, however, are an exception, and although it has a very large population, it falls behind two megaregions in terms of passenger flow.

Standardizing passenger flow does not produce a clear frontrunner for a megaregion that is more apt to passenger flow. The Piedmont and Southern Florida megaregions are consistently at the top of rankings of standardized flows by area, population, and economic productivity, but other megaregions are at the top for some and at the bottom for others. The Northeast for example is at the top of trip production per square mile, but the bottom megaregion when comparing standardizations by population and economic productivity. Non-megaregion areas consistently are at the bottom of the standardized rankings, and appear to lag behind the megaregions in terms of passenger flow rate.

Freight flows have a consistent group of megaregions which fall at the top and bottom of any standardized ranking. Southern Florida is at the top of all the standardized rankings, splitting only the ranking by area with the Northeast. This shows the megaregion is very active in freight movements for the size of its population, area, and economy. Just as Southern Florida dominates the top, the Arizona Sun Corridor and the Gulf Coast have the lowest standardized freight flows.

It must be noted that international freight has the largest effect on the flow of freight in U.S. As a whole, the country imports much more than it exports, an almost 25% different. It follows that most of the megaregions, except Cascadia and the Gulf Coast, have higher exports. It appears that the megaregions most likely to be involved with international freight, those along the coasts, are at the top of the standardized rankings.

4.3 Origin-Destination Megaregion Pairs

The air passenger and freight flows between megaregion, non-megaregion areas, and international markest provide insight into the social and economic connections between populations and industries. In this section, the origin-destination flows between pairs of megaregions, non-megaregion areas, and internationally are analyzed. Through a ranking of top pairs, the strongest connections are examined and relationships are found. As such, this section only focuses on the largest flows, while the section after provides a megaregion-by-megaregion examination of the flow of each. The comparisons that follow are for both passenger and freight flows, looking at the gross totals, and normalizations by area, population, and economic productivity.

4.3.1 Gross Volume of OD Pair Movements

The top flows between the areas in the study are listed in the following section. These flows are the gross flows over the course of the study period. Each of the flows is described by two endpoints, the flow between them, the directional flows, and the difference between the directional flows. Pairings are described as being

Intermegaregional (Intermega), Intramegaregional (Intramega), Non-megaregional (Non-mega), and International.

4.3.1.1 Passenger Traffic

The largest megaregions, the Northeast and Midwest dominate the rankings of passenger flow pairs. Twelve of the top twenty pairings of flows, including the entire top five, have one endpoint within either the Northeast or the Midwest megaregions, as seen in Table 4.13. These megaregions, large in population and economic production, are not surprisingly very significant players in the U.S. air industry. Together, as well, they make up the top pairing, with 688 million passengers.

The Northeast has a strong connection to other countries because it contains the nation's financial (New York) and government (Washington, D.C.) centers, and thus the number two pairing is the Northeast and International airports, with 660 million passengers. As well, the Northeast has a strong connection to Southern Florida, and this pairing is the fifth largest in volume with 500 million passengers. The Northeast's flows with the Piedmont megaregion (349 million), non-megaregion areas (301), and its intramega flows (256) also make the Top 20.

The Midwest is the largest megaregion by area with long distances between many of its largest cities. There is a strong connection between these cities, causing the Midwest intramega flows to land at third on the list with 616 million passenger trips. The Midwest also has a strong connection with non-megaregion areas, which is in fourth place with 560 million passengers. Other connections in the Top 20 for the Midwest are with Southern Florida (323 million), the Piedmont (306), International (291), and Southern California (283).

Table 4.13: Top 20 Megaregion Passenger Flow Pairs

Total Flow (millions)	A	B	Flow Type	A to B (millions)	B to A (millions)	% Difference in Directional Flows
688	Midwest	Northeast	Intermega	344	344	-0.2%
660	Northeast	International	International	328	332	-1.1%
616	Midwest	Midwest	Intramega	616		
560	Midwest	Non-mega	Non-mega	280	281	-0.4%
500	Northeast	Southern Florida	Intermega	250	250	-0.1%
394	Northern California	Southern California	Intermega	196	197	-0.3%
356	Southern Florida	International	International	177	178	-0.5%
351	Piedmont	Non-mega	Non-mega	176	175	0.3%
349	Northeast	Piedmont	Intermega	174	175	-0.3%
323	Midwest	Southern Florida	Intermega	161	162	-1.0%
322	Non-mega	Non-mega	Non-mega	322		
320	Texas Triangle	Non-mega	Non-mega	160	160	-0.3%
316	Piedmont	Southern Florida	Intermega	159	157	0.9%
306	Midwest	Piedmont	Intermega	153	153	0.4%
301	Northeast	Non-mega	Non-mega	151	150	0.4%
186	Texas Triangle	Texas Triangle	Intramega	186		
291	Midwest	International	International	144	147	-1.8%
287	Southern California	International	International	145	143	1.4%
283	Midwest	Southern California	Intermega	141	142	-1.1%

Several other megaregions show up prominently in the Top 20 pairs. The Piedmont is one part of four pairings, Southern Florida part of four pairings, and Southern California part of three pairings. The Texas Triangle is interesting because it only shows up in two pairings, one of which is its intramega flow (only one of three intramega flows on the list besides the Northeast and Midwest). The other is its pairing with non-megaregional areas. Four of the megaregions are not represented anywhere on the Top 20 list.

The Top 20 list is mixed in its types of pairings, with several international, non-mega, and intramega flows. Intermega flows are the most common on the list, however, with eight of the twenty pairings. The only pairing not involving the eastern megaregions is between Northern California and Southern California, displaying the strong connection between the two California megaregions. There is one pairing that spans the nation east to west, making the list at number 20 between the Midwest and Southern California. The remaining intermega pairings are between the four eastern megaregions: Midwest, Northeast, Piedmont, and Southern Florida. Every possible combination between these four megaregions is represented in the Top 20, thus showing the dominance in volume the eastern megaregions have over the U.S. airport system.

The gross passenger flow pairs, solely between megaregions, are shown in Figure 4.3. On this map, international and non-megaregion flows are not shown.

<u>4.3.1.2 Freight Traffic</u>

It is clear that freight flows are dominated strongly by international flows, which make up nine of the Top 20. The top five of the rankings are all movements to and from the international market, as seen in Table 4.14. These top flows are from four megaregions

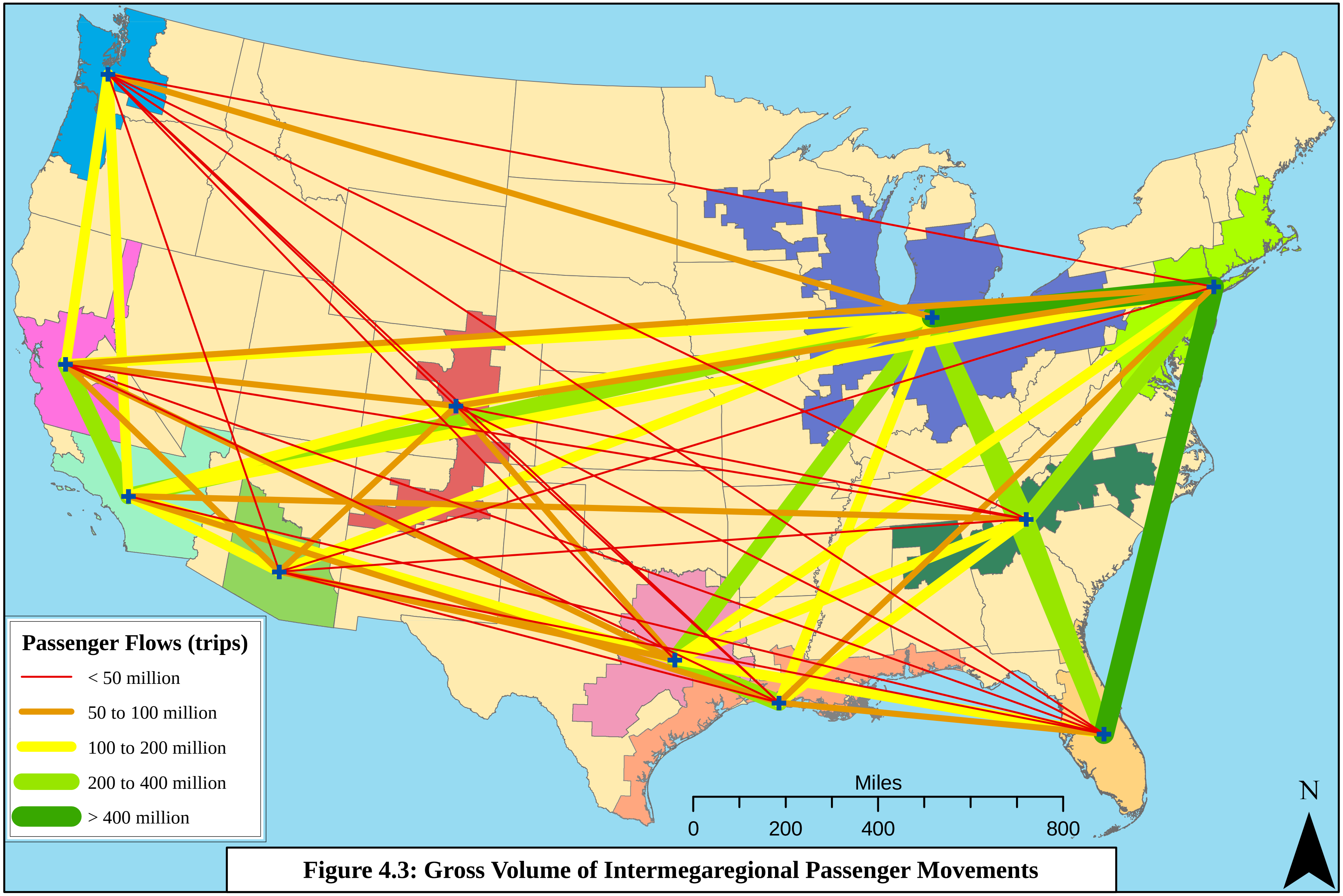

Figure 4.3: Gross Volume of Intermegaregional Passenger Movements

Table 4.14: Top 20 Megaregion Freight Flow Pairs

Total Flow (billions lbs)	A	B	Flow Type	A to B (billions lbs)	B to A (billions lbs)	% Difference in Directional Flows
68.6	Northeast	International	International	30.0	38.6	-25.3%
51.6	Southern Florida	International	International	24.0	27.5	-13.6%
38.7	Midwest	International	International	17.4	21.3	-20.4%
33.1	Southern California	International	International	13.9	19.2	-32.5%
30.6	Non-mega	International	Non-mega/International	12.2	18.4	-40.9%
24.0	Midwest	Non-Mega	Non-mega	11.5	12.5	-8.8%
15.4	Midwest	Northeast	Intermega	8.2	7.2	-12.1%
15.3	Non-mega	Non-Mega	Non-mega	15.3		
13.4	Northern California	International	International	6.0	7.4	-21.6%
12.2	Piedmont	International	International	5.5	6.7	-18.3%
11.6	Texas Triangle	International	International	5.8	5.9	-2.0%
11.4	Southern California	Non-Mega	Non-mega	5.6	5.8	-3.1%
11.2	Northeast	Non-Mega	Non-mega	5.6	5.6	-0.9%
10.1	Midwest	Midwest	Intramega	10.1		
8.5	Midwest	Southern California	Intermega	4.0	4.5	-10.2%
6.1	Midwest	Texas Triangle	Intermega	3.3	2.8	14.8%
6.0	Northern California	Non-Mega	Non-mega	3.2	2.8	11.7%
5.9	Southern Florida	Non-Mega	Non-mega	2.8	3.1	-11.2%
5.5	Texas Triangle	Non-Mega	Non-mega	2.6	2.9	-12.4%
4.9	Gulf Coast	International	International	2.8	2.1	25.2%

and non-megaregion areas: Northeast, 68.6 billions of pounds of freight; Southern Florida, 51.6; Midwest, 38.7; Southern California, 33.1; and non-megaregion areas, 30.6. Four other megaregions also have flows internationally that make the Top 20: Northern California, Piedmont, Texas Triangle, and the Gulf Coast. Of all these megaregions, only the Gulf Coast is a net exporter.

There is also a large number of freight flows to and from non-megaregion areas, making up eight of the Top 20. The top flow is with the international market, and the remaining seven are to six of the megaregions (Midwest, Southern California, Northeast, Northern California, Southern Florida, and the Texas Triangle) and the internal freight flows of non-megaregion areas.

The remaining freight flows in the Top 20, the intermega and intramega flows, all involve the Midwest megaregion. The Midwest freight flow to and from the Northeast is seventh on the list with 15.4 billions of pounds of freight, while farther down are the freight flows to and from Southern California and the Texas Triangle. The Midwest intramega flow is the only one in the Top 20.

Freight flows have a high percent difference between directional movements. While passenger flows are relatively even in both directions (the highest percent difference in the Top 20 list is 1.8%), freight flows are very skewed to one area in the pairing. The smallest percent difference for the Top 20 freight flows is 0.9% (Northeast to non-megaregion areas), however, the majority are greater than 10%, with the largest being 40.9% (non-megaregion areas to internationally).

The gross passenger flow pairs between megaregions and non-megaregion areas are also shown in Figure 4.4. On this map, international flows are not shown, and non-megaregion flows are represented by an arbitrary point in Montana.

4.3.2 OD Pair Movements Standardized by Area

Standardizing the gross volumes of passenger and freight movements by area provides a more level playing field for comparing the megaregions; the Midwest is many times larger than the smaller megaregions. Each of the flows is described by two endpoints, the standardized flow between them, the standardized directional flows, and the percent difference between the directional flows. There are no pairings that include the international market in this section because it is not possible to determine the spatial area for this market of airports.

4.3.2.1 Passenger Traffic

When standardizing by area for passenger flows, the resulting pairs are much more inclusive of all the megaregions, as seen in Table 4.15, with ten of the eleven megaregions represented in the Top 20. Only the Front Range is not represented in this set. Also noteworthy is the absence of non-megaregion areas; the large expanse this area covers causes its standardized flows by area to be small. The six megaregions that were represented very strongly in the gross flows (Northeast, Southern Florida, Southern California, Piedmont, Texas Triangle, and the Midwest) also are represented well when standardized by area. Each of these six megaregions has between four to six pairs on the Top 20 list. Northern California and the Gulf Coast are in two pairings, and Cascadia and the Arizona Sun Corridor are each part of one pairing.

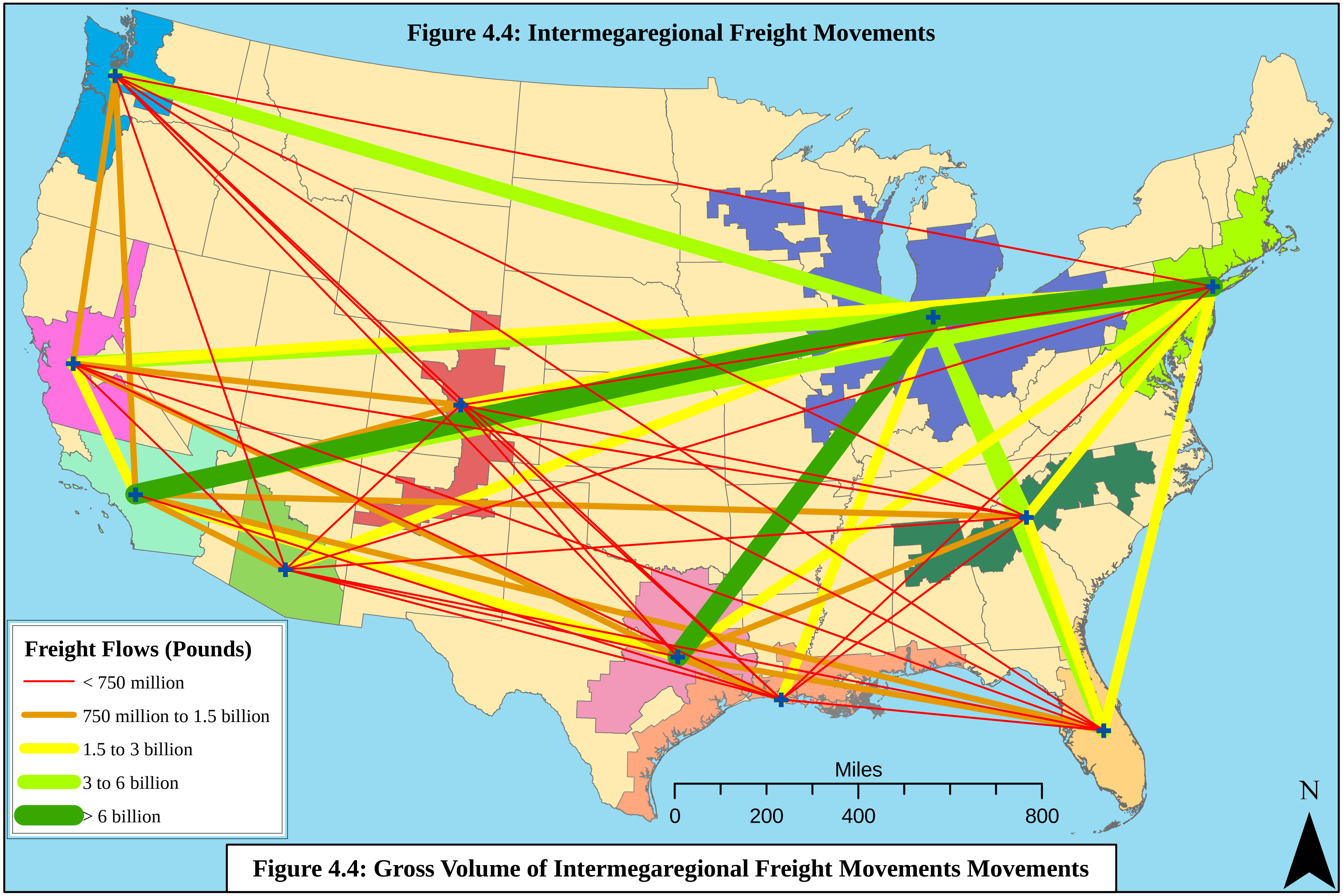

Figure 4.4: Gross Volume of Intermegaregional Freight Movements Movements

Table 4.15: Top 20 Megaregion Passenger Flow Pairs by Area

Total Flow (pax/sq mi)	A	B	Flow Type	A to B (pax/sq mi)	B to A (pax/sq mi)	% Difference in Directional Flows
4977.8	Northeast	Southern Florida	Intermega	2487.6	2490.2	-0.1%
4151.7	Northeast	Northeast	Intramega	4151.7		
3576.1	Northern California	Southern California	Intermega	1785.4	1790.8	-0.3%
3209.1	Piedmont	Southern Florida	Intermega	1611.9	1597.2	0.9%
3005.7	Midwest	Midwest	Intramega	3005.7		
2878.3	Piedmont	Northeast	Intermega	1441.3	1437.0	0.3%
2579.8	Midwest	Northeast	Intermega	1288.7	1291.1	-0.2%
2192.7	Texas Triangle	Texas Triangle	Intramega	2192.7		
1925.5	Southern California	Southern California	Intramega	1925.5		
1733.7	Piedmont	Piedmont	Intramega	1733.7		
1554.3	Gulf Coast	Texas Triangle	Intermega	777.0	777.3	0.0%
1517.9	Northeast	Southern California	Intermega	748.0	769.9	-2.9%
1458.3	Arizona Sun Corridor	Southern California	Intermega	732.2	726.1	0.8%
1441.1	Southern Florida	Southern Florida	Intramega	1441.1		
1326.0	Midwest	Southern Florida	Intermega	659.7	666.2	-1.0%
1226.2	Cascadia	Northern California	Intermega	611.2	615.0	-0.6%
1221.9	Gulf Coast	Gulf Coast	Intramega	1221.9		
1199.2	Southern California	Texas Triangle	Intermega	595.3	603.9	-1.4%
1177.0	Northeast	Texas Triangle	Intermega	593.9	583.1	1.8%
1154.8	Midwest	Piedmont	Intermega	578.4	576.4	0.4%

The Northeast to Southern Florida pairing is the top pairing when standardized by area, with 4977.8 passenger trips per square mile. In second is the intramega flow for the Northeast, at 4151.7. The trans-California flow between the two California megaregions is third with 3576.1, followed by the pairing of the Piedmont and Southern Florida with 3209.1. The top five is concluded by the intramega flow in the Midwest with 3005.7.

Intramega flows are much more strongly represented when standardized by area. Each of the six megaregions predominant in gross passenger flows have their intramega flows in the Top 20 list by area. A seventh megaregion, the Gulf Coast, also joins this list, although below the other six. More pairs that span coasts or link to central megaregions show up on the list standardized by area. This includes the Northeast to Southern California, Southern California to the Texas Triangle, and the Northeast to the Texas Triangle.

Also on the showing up on the Top 20 list are pairings between megaregions that are near to each other, away from the eastern megaregions. Included are the Gulf Coast and the Texas Triangle, Arizona Sun Corridor and Southern California, and Cascadia and Northern California.

4.3.2.2 Freight Traffic

Without the presence of international flows, and the large size of non-megaregion areas, freight flows standardized by area consists of mostly intermega flows, as seen in Table 4.16. The majority of these freight flows, even when standardized by area, are dominated by the Midwest and the Northeast. Southern California, Southern Florida, Northern California, and the Texas Triangle are also well represented.

Table 4.16: Top 20 Megaregion Freight Flow Pairs by Area

Total Flow (pounds/sq mi)	A	B	Flow Type	A to B (pounds/sq mi)	B to A (pounds/sq mi)	% Difference in Directional Flows
57644.9	Midwest	Northeast	Intermega	30569.1	27075.7	12.1%
49268.6	Midwest	Midwest	Intramega	49268.6		
38460.5	Northeast	Southern California	Intermega	15411.5	23049.0	-39.7%
31779.4	Midwest	Southern California	Intermega	15076.6	16702.8	-10.2%
26153.4	Northeast	Northern California	Intermega	12081.7	14071.7	-15.2%
24837.9	Northeast	Northeast	Intramega	24837.9		
24674.0	Northeast	Southern Florida	Intermega	10179.9	14494.1	-35.0%
22563.1	Northern California	Southern California	Intermega	11262.5	11300.6	-0.3%
21179.6	Midwest	Texas Triangle	Intermega	11375.4	9804.2	14.8%
19358.3	Midwest	Northern California	Intermega	9539.3	9819.1	-2.9%
18231.0	Midwest	Piedmont	Intermega	9303.3	8927.8	4.1%
17633.6	Midwest	Southern Florida	Intermega	9709.1	7924.5	20.2%
16710.1	Piedmont	Southern Florida	Intermega	7921.0	8789.1	-10.4%
16081.3	Northeast	Piedmont	Intermega	8531.9	7549.3	12.2%
15334.9	Southern California	Texas Triangle	Intermega	8159.7	7175.3	12.8%
15087.6	Cascadia	Northern California	Intermega	6369.7	8717.8	-31.1%
13498.3	Cascadia	Midwest	Intermega	6497.8	7000.5	-7.4%
10839.9	Southern Florida	Texas Triangle	Intermega	5172.4	5667.5	-9.1%
10553.1	Northeast	Texas Triangle	Intermega	5682.0	4871.0	15.4%
10496.2	Front Range	Midwest	Intermega	4526.6	5969.6	-27.5%

The pairing between the Midwest and the Northeast is the top ranked pair with around 57,000 pounds of freight per square mile. The Midwest intramega flow is in second with around 49,000. The remainder of the top five is from the Midwest or Northeast to the two California megaregions. In fact, the California megaregions have a strong presence in freight flows by area, part of seven pairings.

The freight flows standardized by area also have large differences in directional flows, even without the international market being represented on the list. The smallest difference in directional flows is between Northern and Southern California with 0.3%. The difference is as large as 39.7% between the Northeast and Southern California, with the greater share heading east. In general, the Midwest and Southern California are producing air freight, while the Northeast and Texas Triangle are attracting air freight.

4.3.3 OD Pair Movements Standardized by Population

Examining the OD pairs of megaregion and non-megaregion areas for passenger and freight volumes standardized by population reveals the tendencies of each area's populace. The top pairings of areas show which populations are more connected than others through air travel and sending air freight. There are no pairings that include the international market in this section because it is not possible to determine the combined population bases for these airports.

4.3.3.1 Passenger Traffic

What is first apparent from the Top 20 list of pairs standardized by population is that every megaregion is represented on the list. It is clear that all megaregions share close connections in passenger travel to a megaregion very close to them, as seen in Table 4.17.

Table 4.17: Top 20 Megaregion Passenger Flow Pairs by Population

Total Flow (pax/pop of A&B)	A	B	Flow Type	A to B (pax/pop of A&B)	B to A (pax/pop of A&B)	% Difference in Directional Flows
11.5	Texas Triangle	Texas Triangle	Intramega	11.5		
11.5	Midwest	Midwest	Intramega	11.5		
11.4	Northern California	Southern California	Intermega	5.7	5.7	-0.3%
10.7	Piedmont	Southern Florida	Intermega	5.4	5.3	0.9%
7.9	Gulf Coast	Texas Triangle	Intermega	4.0	4.0	-0.1%
7.8	Northeast	Southern Florida	Intermega	3.9	3.9	-0.1%
7.0	Piedmont	Piedmont	Intramega	7.0		
6.7	Midwest	Northeast	Intermega	3.3	3.3	-0.2%
6.1	Arizona Sun Corridor	Southern California	Intermega	3.1	3.0	0.8%
6.0	Gulf Coast	Gulf Coast	Intramega	6.0		
5.8	Cascadia	Northern California	Intermega	2.9	2.9	-0.6%
5.5	Arizona Sun Corridor	Front Range	Intermega	2.7	2.7	0.2%
5.4	Southern California	Southern California	Intramega	5.4		
5.4	Northeast	Piedmont	Intermega	2.7	2.7	-0.3%
5.2	Northeast	Northeast	Intramega	5.2		
4.7	Midwest	Southern Florida	Intermega	2.3	2.4	-1.0%
4.6	Texas Triangle	Southern California	Intermega	2.3	2.3	1.4%
4.6	Front Range	Texas Triangle	Intermega	2.3	2.3	-2.4%
4.5	Midwest	Piedmont	Intermega	2.2	2.2	0.4%
4.4	Midwest	Non-mega	Non-mega	2.2	2.2	-0.4%

Looking at megaregions which did make the top gross flow list, the following make the Top 20 by population: the Gulf Coast and Texas Triangle, Arizona Sun Corridor and Southern California, Arizona Sun Corridor and Front Range, Front Range and Texas Triangle, and Cascadia and Northern California. As well, the flows between the megaregions very active in passenger travel still have a large presence on this list.

The top five in the rankings have a wide array of megaregions represented, and the flows of passenger trips per person are not vastly different as in other lists. The intramega flows of the Texas Triangle and the Midwest top the list, both around 11.5 trips per person. The pairing of Northern California and Southern California is in third with 11.4 trips per person. In fourth is the Piedmont to Southern Florida with 10.7, and in fifth is the Gulf Coast to the Texas Triangle with 7.9.

Intramega flows show up six times on the Top 20 list standardized by population. Already mentioned are those for Texas Triangle and the Midwest. In addition, the Piedmont, Gulf Coast, Southern California, and the Northeast also have high levels of internal passenger traffic per capita.

Only one flow outside of the megaregions appears on the list: the flow from the Midwest to non-megaregion areas, with 4.4 trips per capita.

4.3.3.2 Freight Traffic

By population, the Midwest and non-megaregion areas dominate the list of freight movements standardized by population. Together they encompass 15 of the Top 20 pairs, including nine of the top ten, as seen in Table 4.18. The large volume of air freight that originates and is destined for the Midwest and non-megaregion areas differs though in

Table 4.18: Top 20 Megaregion Freight Flow Pairs by Population

Total Flow (pounds/pop of A&B)	A	B	Flow Type	A to B (pounds/pop of A&B)	B to A (pounds/pop of A&B)	% Difference in Directional Flows
208.7	Non-mega	Non-Mega	Non-mega	208.7		
188.9	Midwest	Non-Mega	Non-mega	90.3	98.6	-8.8%
187.9	Midwest	Midwest	Intramega	187.9		
148.8	Midwest	Northeast	Intermega	78.9	69.9	12.1%
119.8	Southern California	Non-Mega	Non-mega	59.0	60.8	-3.1%
112.2	Midwest	Southern California	Intermega	53.2	58.9	-10.2%
91.3	Northeast	Non-Mega	Non-mega	45.4	45.9	-0.9%
87.8	Midwest	Texas Triangle	Intermega	47.2	40.6	14.8%
73.7	Midwest	Northern California	Intermega	36.3	37.4	-2.9%
71.8	Northern California	Southern California	Intermega	35.8	36.0	-0.3%
71.6	Cascadia	Northern California	Intermega	30.2	41.4	-31.1%
70.3	Midwest	Piedmont	Intermega	35.9	34.4	4.1%
69.6	Northern California	Non-Mega	Non-mega	36.8	32.8	11.7%
66.7	Southern Florida	Non-Mega	Non-mega	31.5	35.2	-11.2%
66.5	Northeast	Southern California	Intermega	26.6	39.9	-39.7%
62.8	Midwest	Southern Florida	Intermega	34.6	28.2	20.2%
61.5	Texas Triangle	Non-Mega	Non-mega	28.8	32.6	-12.4%
59.2	Southern California	Texas Triangle	Intermega	31.5	27.7	12.8%
55.7	Cascadia	Midwest	Intermega	26.8	28.9	-7.4%
55.6	Piedmont	Southern Florida	Intermega	26.4	29.3	-10.4%

that the Midwest is predominantly an exporter of freight to other areas while non-megaregion areas are predominantly importing.

The top five of the list begins with the flows between all the non-megaregion areas, with 208.7 pounds of freight per person. The Midwest to non-megaregion area flow is in second with 188.9, while the Midwest intramega flow is in third with 187.9. In fourth is the Midwest and the Northeast pairing with 148.8, and the pairing of Southern California and non-megaregion areas is in fifth with 119.8.

Only eight megaregions are represented on this list, with the Front Range, Arizona Sun Corridor, and the Gulf Coast being absent. Southern California appears five times, the second most to the Midwest. Northern California appears four times. The Northeast, Southern Florida, and the Texas Triangle appear three times, while Cascadia and the Piedmont appear twice. All but the last two have a pairing with non-megaregion areas on the list.

4.3.4 OD Pair Movements Standardized by Economic Productivity

A comparison of passenger and freight flows standardized by economic productivity is discussed in the following section. The size of two economies and their flows helps to understand the economic bond between them. There are no pairs that include the international market in this section because it is not possible to determine the combined economic bases for these airports.

4.3.4.1 Passenger Traffic

Standardized by economic productivity, the top pairs between areas are representative of all the megaregions, whether in intramega or intermega flows. As seen in Table 4.19, all

Table 4.19: Top 20 Megaregion Passenger Flow Pairs by Economic Productivity

Total Flow (pax/$ trillions)	A	B	Flow Type	A to B (pax/ $ trillions)	B to A (pax/ $ trillions)	% Difference in Directional Flows
297.3	Midwest	Midwest	Intramega	297.3		
288.5	Piedmont	Southern Florida	Intermega	144.9	143.6	0.9%
237.1	Northern California	Southern California	Intermega	118.3	118.7	-0.3%
227.2	Texas Triangle	Texas Triangle	Intramega	227.2		
212.6	Piedmont	Piedmont	Intramega	212.6		
165.2	Gulf Coast	Texas Triangle	Intermega	82.6	82.6	0.0%
156.3	Northeast	Southern Florida	Intermega	78.1	78.2	-0.1%
147.5	Midwest	Northeast	Intermega	73.7	73.8	-0.2%
134.9	Gulf Coast	Gulf Coast	Intramega	134.9		
131.4	Arizona Sun Corridor	Southern California	Intermega	66.0	65.4	0.8%
122.0	Cascadia	Northern California	Intermega	60.8	61.2	-0.6%
120.6	Midwest	Southern Florida	Intermega	60.0	60.6	-1.0%
120.4	Arizona Sun Corridor	Front Range	Intermega	60.3	60.1	0.2%
119.4	Midwest	Piedmont	Intermega	59.8	59.6	0.4%
114.9	Southern California	Southern California	Intramega	114.9		
113.4	Northeast	Piedmont	Intermega	56.6	56.8	-0.3%
105.6	Midwest	Non-mega	Non-mega	52.7	52.9	-0.4%
101.5	Gulf Coast	Piedmont	Intermega	50.7	50.8	-0.2%
99.6	Non-mega	Non-mega	Non-mega	99.6		
98.8	Northeast	Northeast	Intramega	98.8		

megaregions have a pairing that makes the Top 20 with another megaregion that is in the same geographic vicinity: the Front Range and the Arizona Sun Corridor, the Arizona Sun Corridor and Southern California, and Cascadia and Northern California. Other megaregions show up multiple times in the list, but still are paired with spatially close megaregions with which they have strong passenger traffic ties. The four eastern megaregions (Northeast, Midwest, Southern Florida, and Piedmont) have six possible pairings between the set, and all six are in the Top 20.

Intramega pairings show up six times in the Top 20. These are the same few intramega flows which showed up on other passenger flow lists: Midwest, Texas Triangle, Piedmont, Gulf Coast, Southern California, and the Northeast. The first three of these show up in the top five of the rankings with 297.3, 227.2, and 212.6 passenger trips per trillion dollars of economic production. The remaining two pairings in the top five are intermega: Piedmont and Southern Florida with 288.5, and the California megaregions' pairing with 237.1.

Non-megaregion flows do not show up dominantly in the Top 20, with only two near the bottom of the list. The Midwest and non-megaregion area pairing is seventeenth on the list, while the internal non-megaregion area flows are nineteenth. The non-megaregion areas do not have high levels of passenger traffic that corresponds with its larger economy size, affecting its standardized rate.

4.3.4.2 Freight Traffic

Eight of the Top 20 freight flows standardized by economic production are pairs that involve non-megaregion areas, as seen in Table 4.20. The top ranked of these is the freight movement internal to non-megaregion areas, with over 4700 pounds of freight per

Table 4.20: Top 20 Megaregion Freight Flow Pairs by Economic Productivity

Total Flow (pounds/$ trillion)	A	B	Flow Type	A to B (pounds/ $ trillion)	B to A (pounds/ $ trillion)	% Difference in Directional Flows
4873.0	Midwest	Midwest	Intramega	4873.0		
4742.6	Non-mega	Non-Mega	Non-mega	4742.6		
4528.8	Midwest	Non-Mega	Non-mega	2164.7	2364.2	-8.8%
3295.9	Midwest	Northeast	Intermega	1747.8	1548.1	12.1%
2727.3	Midwest	Southern California	Intermega	1293.9	1433.4	-10.2%
2673.7	Southern California	Non-Mega	Non-mega	1316.1	1357.6	-3.1%
2123.1	Midwest	Texas Triangle	Intermega	1140.3	982.8	14.8%
1929.0	Northeast	Non-Mega	Non-mega	960.0	969.0	-0.9%
1885.2	Midwest	Piedmont	Intermega	962.0	923.2	4.1%
1818.1	Midwest	Northern California	Intermega	895.9	922.2	-2.9%
1603.6	Midwest	Southern Florida	Intermega	883.0	720.7	20.2%
1555.8	Northern California	Non-Mega	Non-mega	823.3	732.5	11.7%
1531.6	Southern Florida	Non-Mega	Non-mega	723.0	808.6	-11.2%
1502.5	Piedmont	Southern Florida	Intermega	712.2	790.3	-10.4%
1501.1	Cascadia	Northern California	Intermega	633.7	867.4	-31.1%
1495.6	Northern California	Southern California	Intermega	746.6	749.1	-0.3%
1413.5	Cascadia	Midwest	Intermega	680.4	733.1	-7.4%
1359.5	Texas Triangle	Non-Mega	Non-mega	637.7	721.8	-12.4%
1309.2	Northeast	Southern California	Intermega	524.6	784.6	-39.7%
1269.3	Piedmont	Non-Mega	Non-mega	631.3	638.0	-1.0%

trillion dollars of economic production. The Midwest, Southern California, Northeast, Northern California, Southern Florida, Texas Triangle, and Piedmont megaregions also have pairings with non-megaregion areas that make the Top 20.

The only flow amongst the Top 20 which is intramega is for the Midwest. It is, however, the only intramega flow on the entire list. The number two and three flows are the internal non-megaregion area flows and the pairing of non-megaregion areas with the Midwest. It is clear these two areas are significant producers of freight for the economies happening within. The number four and five flows are intermega, the pairing between the Midwest and the Northeast and the pairing between the Midwest and Southern California.

The dominant flow pairings on the list involve the Midwest heavily, with nine of the twenty involving the largest of the megaregions. Those intermega flows which do not involve the Midwest are Piedmont and Southern Florida, Cascadia and Northern California, Northern California and Southern California, and the Northeast and Southern California.

4.3.5 Summary

The OD pairs of megaregions and non-megaregion areas for passenger and freight movements do not deviate from what would be expected. In passenger traffic, the intermega and intramega flows are dominant on the lists that are standardized by area, population, and economic production. Denser in population and with larger economies, the megaregion populations travel to other megaregions quite frequently due to economic ties and dynamic locations that are ripe for travel. International traffic heads to the megaregions most expected, those with strong ties to international economies: the Northeast, Midwest, Southern California, and Southern Florida.

Passenger pairings that show up consistently as the most heavily traveled for passenger traffic are: Northeast and Southern Florida, Midwest intramega flows, Northern California and Southern California, and the Piedmont and Southern Florida.

For freight traffic, the top flows are predominantly to and from the international market and non-megaregion areas. Sixteen of the Top 20 gross flows go to these two areas. On the standardized lists, which do not include international, non-megaregion flows show up very strongly. The only one in which they are absent is in area, where the non-megaregion spatial area is large enough to create smaller standardized flows. The Midwest is a dominant megaregion in air freight and on standardized lists ends up in many of the top pairs. This shows the close ties that many megaregions have with the Midwest in terms of air freight. The top freight flow pairs less often include the less populated megaregions with smaller economies, even when standardized.

Freight pairs that show up consistently as the most heavily traveled for freight traffic are: Midwest and non-megaregion areas, Midwest intramega flows, Midwest and Northeast, non-megaregion internal flows, and the Midwest and Southern California.

One interesting result is the tendency for megaregions' top passenger flow pairing to be a megaregion nearby. The four eastern megaregions have flows between them that consistently show up in the Top 20 of all lists. When smaller megaregions break through on the list, they often do so with flows to the closest geographical megaregion. This shows a tendency for megaregions to have one or a few close ties to megaregions that are close to them. Three of the consistent top flows outside the eastern megaregions are between Northern California and Southern California, Arizona Sun Corridor and Southern California, the Gulf Coast and Texas Triangle, and Cascadia and Northern California.

Intramega flows are high for passenger traffic and low for freight traffic. There is very little intramega traffic for freight flow, as air freight has a tendency to be moved over longer distances, and intramega freight often can go by truck. Intramega passenger traffic, on the standardized lists, is consistently near the top. This gives indication that intramega traffic plays a significant role in megaregion air systems. Consistently highly ranked intramega passenger flows exist for the Midwest, Northeast, Texas Triangle, Piedmont, Southern California, and Gulf Coast. Only the Midwest has a consistently a highly ranked intramega freight flow.

The difference between directional flows is telling of the nature of air freight and passenger movements. Passenger traffic is evenly split between the pair because most passengers flying return to their origin. Freight traffic is the movement of goods which will ultimately be consumed at some points, and thus is not on a return ticket. Thus with percentage differences that are often above 10% and reach above 40%, it is clear that in freight pairings there is a clear net exporter and net importer. This is the strongest between international pairings, as most of the traffic is towards the U.S.

4.4 Individual Megaregions: Origin-Destination Flows

This section discusses the passenger and freight traffic flowing in and out of each U.S. megaregion and the non-megaregion areas. All flow pairs in this section are what were termed intermega, intramega or non-mega flows in the previous section. Intramega flows are discussed in further detail in the subsequent section.

All discussions of flows are based on tables located in Appendix B. Tables B.1 and B.3 provide the raw T-100data summed up as OD flows between megaregions for passengers and freight, respectively. In these tables, the flow from the Northeast to the Midwest, for example, is different from the flow in the reverse direction. Thus, the table can be read to find the productions into and attractions out of each megaregion. Tables B.2 and B.4 look similar, but report the combined flows between a given pair of megaregions.

Given the results from the previous section about the top origin-destination movements, flows are discussed differently in this section. Because passenger traffic is relatively balanced within a pair, combined flows in both directions are discussed. Freight flows, however, had significant differences between directional movements. Thus, in the following section there is an additional discussion on the gross volumes of freight flows for attractions to and productions from particular megaregions. Standardized flows for both passenger and freight movements are discussed as combined flows between pairs.

Appendix C provides data on a megaregion by megaregion level. A summary of flows and standardized flows for each megaregion's passenger and freight traffic is shown in each table.

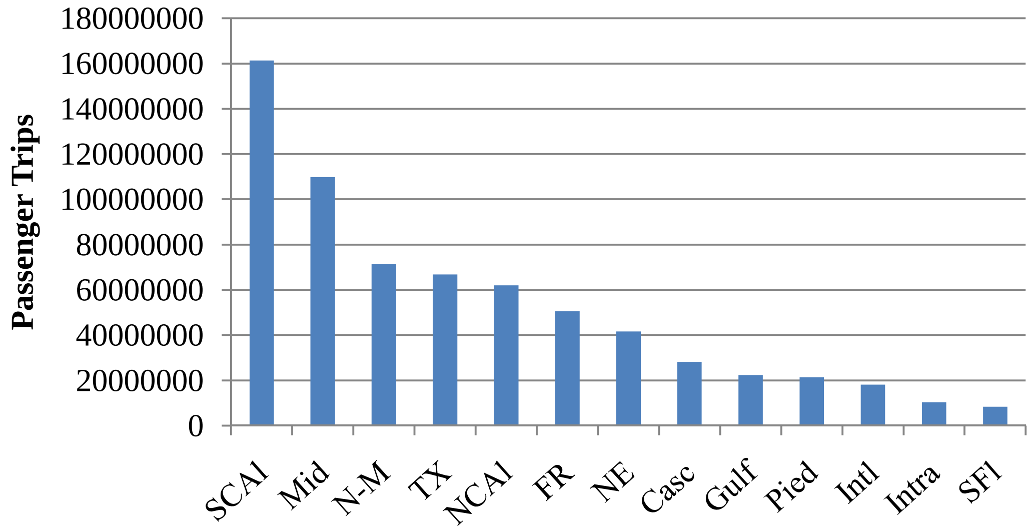

Figure 4.5: Arizona Sun Corridor Passenger Flows

4.4.1 Arizona Sun Corridor

<u>4.4.1.1 Passenger Traffic</u>

The Arizona Sun Corridor's highest passenger flows are with Southern California and the Midwest, as seen in Figure 4.5. After these top two, there are similarly large flows with non-megaregion areas, the Texas Triangle, and Northern California. The Arizona Sun Corridor's lowest passenger flows are to Southern Florida, its intramega flows, and international travel. Table C.1 summarizes the gross and standardized flows.

Examining the megaregion's standardized flows by area, the Arizona Sun Corridor is most connected to the two California megaregions and the Texas Triangle, and least connected to Southern Florida, non-megaregion areas, and the Piedmont.

Standardizing flows for population and economic productivity show similar results. The top three megaregions connected to the Arizona Sun Corridor are Southern

California, Front Range, and Northern California. The least connected are Southern Florida, the Northeast, and non-megaregion areas.

Overall, in terms of passenger flows, it is clear that the Arizona Sun Corridor's connection with Southern California is very strong. Not only does this pairing have the highest gross volume of all the Arizona Sun Corridor's pairs, but is also the top pairing when standardized by area, population, and economic productivity. The Arizona Sun Corridor is also closely tied to other western megaregions such as Northern California and the Front Range. It is least connected to the megaregions on the eastern seaboard: Northeast and Southern Florida. Despite having strong flows to non-megaregion areas, when standardized, these flows are not as significant. The Arizona Sun Corridor is not strongly tied internationally.

4.4.1.2 Freight Traffic

The largest freight flows for the Arizona Sun Corridor are to the Midwest, non-megaregion areas, and Southern California, as seen in Figure 4.6. There is a sloping drop-off to the lower volume pairings. It has the lowest freight connections with Southern Florida, the Gulf Coast, and internally. It is a net exporter to the Front Range megaregion, but a net importer for all other megaregions, non-megaregion areas, and international. The megaregions with which it has the largest differential between exports and imports are the Midwest, Southern California, and the Piedmont, which all send 25% more goods to the Arizona Sun Corridor than they receive. Table C.2 summarizes the gross and standardized flows.

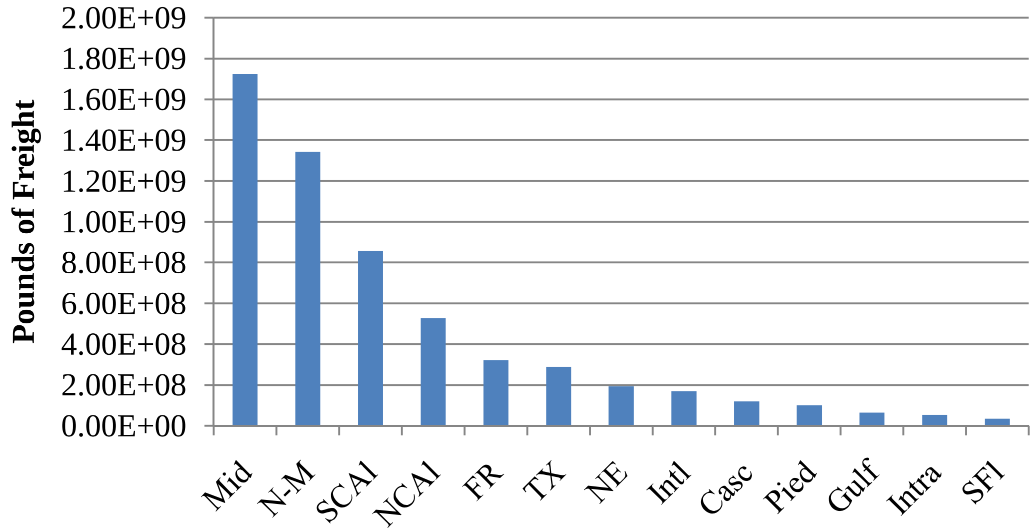

Figure 4.6: Arizona Sun Corridor Freight Flows

The Arizona Sun Corridor's standardized freight flows by area indicate the strongest connections with the two California megaregions and the Midwest. Its weakest connections are with Southern Florida, non-megaregion areas, and the Gulf Coast.

By population, the Arizona Sun Corridor has the strongest connections with the Front Range, Southern California, and Northern California. Its weakest connections are with Southern Florida, the Northeast, and Gulf Coast.

Standardized by economic production, the Arizona Sun Corridor's freight flows are greatest with the Front Range, Midwest, and Southern California. Its lowest flows are with Southern Florida, the Northeast, and Gulf Coast.

In summary, the Arizona Sun Corridor's freight flows are dominated by the California megaregions, particularly Southern California, and the Midwest. It also has a large connection with non-megaregion areas, although not when standardizing the flow. It is a net exporter with the Front Range, another megaregion with which it is strongly connected when standardized. Freight flows are weak with coastal eastern megaregions, particularly Southern Florida. It has a fairly weak international connection for freight.

4.4.2 Cascadia

4.4.2.1 Passenger Traffic

The Cascadia megaregion has strong megaregional ties to the other two western megaregions in California. After non-megaregion areas, the second and third highest volumes are to Northern and Southern California, as seen in Figure 4.7. The fourth highest flow, to the Midwest, is not significantly smaller, but there is a larger drop to the remaining pairings. It is least connected to the megaregions on the opposite end of the country in the southeastern U.S.: Southern Florida, Gulf Coast, and the Piedmont. Table C.3 summarizes the gross and standardized flows.

The standardized flows of Cascadia show that the high gross volumes are also significant on an even playing field. The California megaregions are the top passenger connections standardized by area, population, and economic production. In third by area and economic production are Cascadia’s intramega flows, while by population it is the Front Range. Cascadia’s weakest connection is to Southern Florida in all standardization of flows. The Gulf Coast is the third weakest in all standardizations as well. The second worst by area is non-megaregion areas, and by population and economic production it is the Northeast.

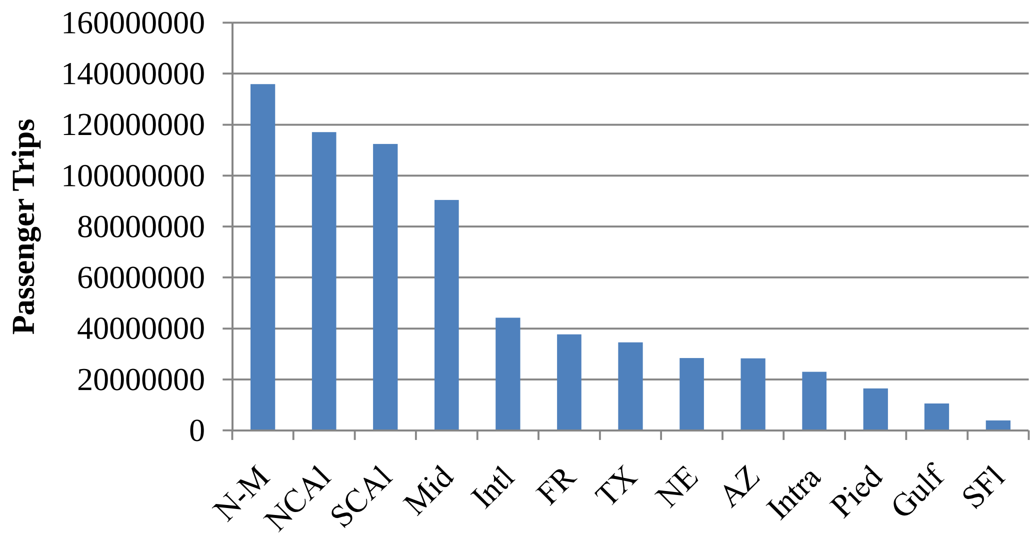

Figure 4.7: Cascadia Passenger Flows

In summary, Cascadia's passenger traffic has a strong western focus, with large volumes, even when standardized, to both California megaregions. Northern California is always the greater of the two. It also has a strong intramega network when standardizing the flows, but by gross volumes it is very connected to non-megaregion areas. Cascadia is the least tied to the eastern and particularly southeastern megaregions of the country. Southern Florida, the Gulf Coast, Northeast, and Piedmont megaregions do not show up high in Cascadia's lists.

4.4.2.2 Freight Traffic

Cascadia is one two U.S. megaregions that are overall net exporters. Not only does it ship more goods internationally by air than it receives, but it also exports to the Piedmont, Northeast, and Gulf Coast more than it imports by over a 50% difference. Cascadia also produces more air freight than it receives to the Front Range, Texas Triangle, the Arizona

Sun Corridor, and Southern Florida. It imports more its nearest neighbors, the two California megaregions, but also from non-megaregion areas.

Cascadia's largest air freight ties are to non-megaregion areas, internationally, and the Midwest. As seen in Figure 4.8, there is a large drop-off to the fourth highest flow with Northern California. Its weakest connections are to the Gulf Coast, Southern Florida, and the Arizona Sun Corridor. Table C.4 summarizes the gross and standardized flows.

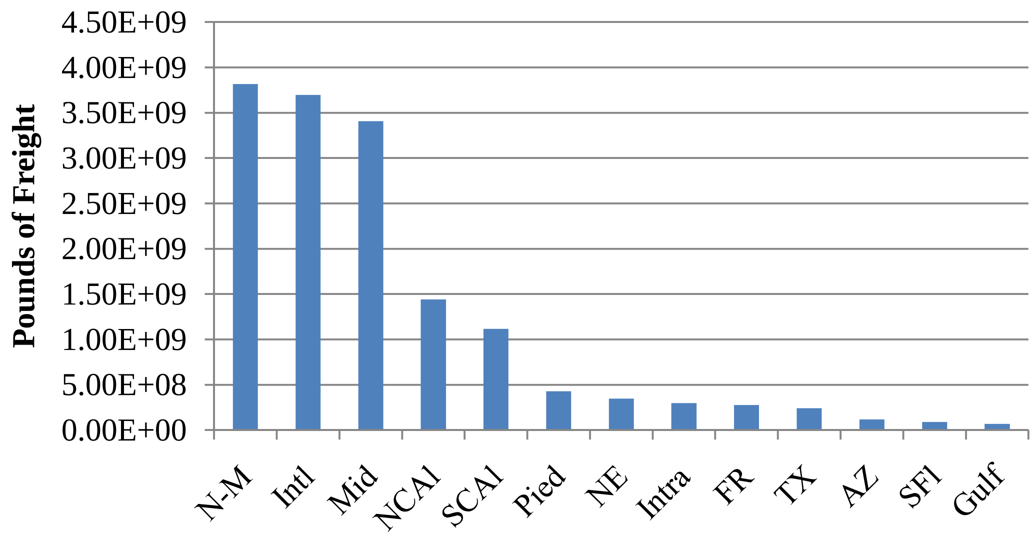

Figure 4.8: Cascadia Freight Flows

Standardized flows by area for Cascadia's freight movements show a strong connection to the two California megaregions and the Midwest. The weakest connections are to the Gulf Coast, Southern Florida, and the Arizona Sun Corridor.

Cascadia's standardized flows by population and economic production are similar. The top three connections are to Northern California, the Midwest, and non-megaregion areas. The weakest freight connections are the Gulf Coast, Southern Florida, and the Northeast.

In summary, Cascadia's freight traffic is primarily to non-megaregions areas, the California megaregions, and the Midwest. All of these are locations with which Cascadia has a net import of flows. It also has a strong freight connection internationally, with which it has a strong export market. Overall, Cascadia primarily exports goods by air freight. Its air freight connections are weak to the southeastern U.S., sending and receiving very little with the Gulf Coast and Southern Florida.

4.4.3 Front Range

4.4.3.1 Passenger Traffic

The Front Range has its strongest passenger connection by gross volume with the Midwest and non-megaregion areas, with Southern California and Texas Triangle behind in third and fourth. As seen in Figure 4.9, its international connection is the weakest of all its connections, and its intramega flows are very low as well. The megaregion with which it is least connected is Southern Florida. Table C.5 summarizes the gross and standardized flows.

When standardizing the Front Range's passenger flows, it is evident that the population travels to places nearby. By area, its top connection is Southern Florida and the Texas Triangle, with the distant Northeast in third. By population and economic production it has strong ties to the Arizona Sun Corridor and Texas Triangle, but also strong intramega flows.

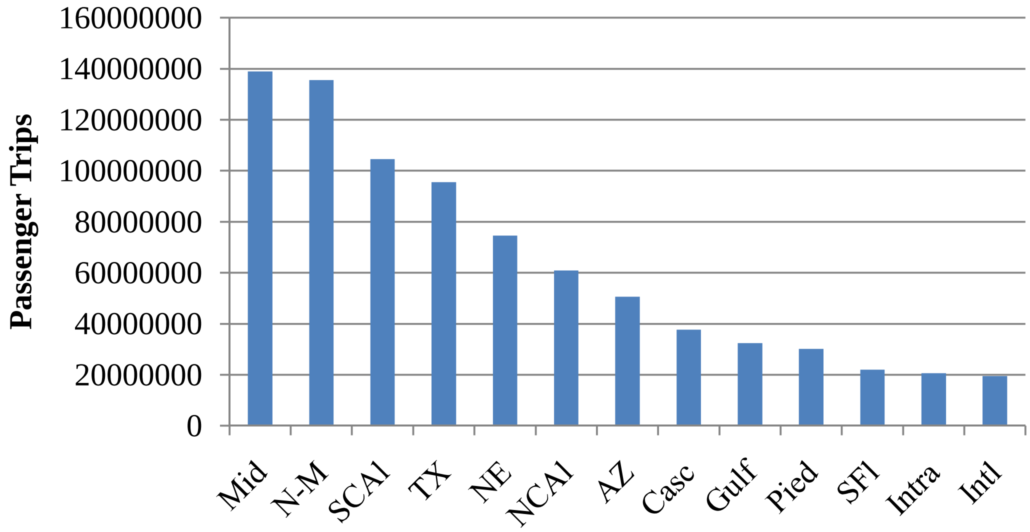

Figure 4.9: Front Range Passenger Flows

The weakest connections for the Front Range when passenger flows are standardized are non-megaregion areas, Southern Florida, and the Piedmont. Although the Northeast was a strong connection by area, by population and economic production it is considered a weak pairing.

Overall, the Front Range has a strong passenger connection with the adjacent megaregions: the Texas Triangle, Midwest, Southern California, and Arizona Sun Corridor. For its population and economic production, it has a high intramega flow volume. It also has strong ties to the non-megaregion areas, appropriately as it is surrounded by great distances on all sides by non-megaregion areas. Its weakest connections are to megaregions in the southeast. It also has a weak international connection.

4.4.3.2 Freight Traffic

The Front Range's strongest freight connections are the same as those for its passenger connection: the Midwest, non-megaregion areas, and Southern California. For freight, Northern California is also a high connection, as seen in Figure 4.10. It has low intramega freight flows, and low volumes to the southeastern U.S.: Southern Florida, Piedmont, and Gulf Coast. The Front Range is a net importer of air freight with all but two areas. Only with Southern California is it a net exporter. The difference in directional flows is greatest with the Texas Triangle and Southern Florida, with a difference of over 70%. Table C.6 summarizes the gross and standardized flows.

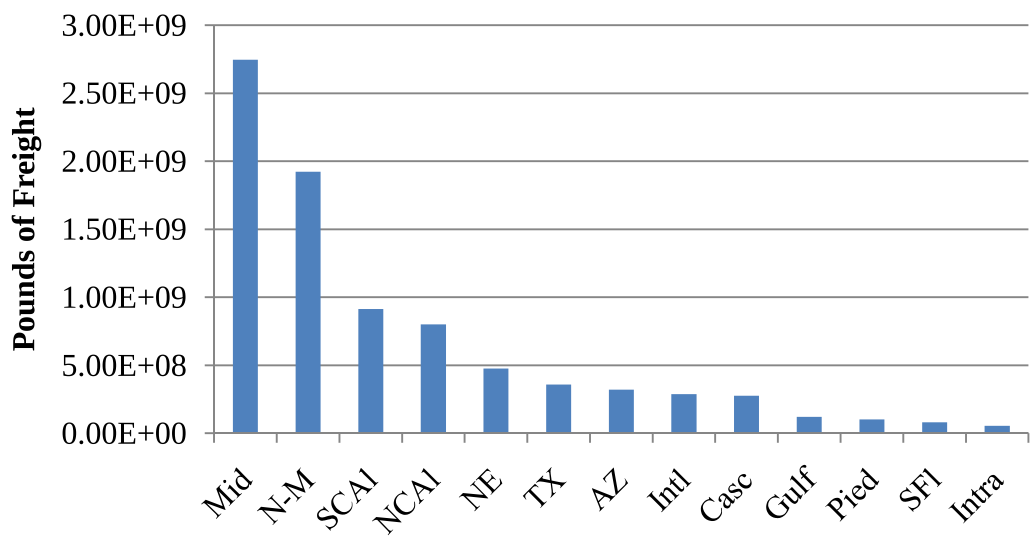

Figure 4.10: Front Range Freight Flows

The Front Range's flows when standardized reveal a tendency to move air freight with western megaregions. Although its top pairing is consistently the Midwest, it also has strong standardized flows with the Arizona Sun Corridor, Northern California, and

Southern California. By area, its standardized flows with non-megaregion areas are low, but otherwise it has low standardized flows with southeastern megaregions: the Gulf Coast, Piedmont, and Southern Florida.

It is noted that overall the Front Range is more strongly connected to western megaregions in terms of freight, and low connections to southeastern megaregions. Its strongest consistent standardized connections are with the Midwest and Northern California. The international freight component is moderate, but the Front Range has a high connection with non-megaregion areas. It is a net importer of goods, a trend that exists with all but two megaregions. It does not send many goods by air internally.

4.4.4 Gulf Coast

4.4.4.1 Passenger Traffic

The Gulf Coast's top pairing is with the Texas Triangle, which is influenced by the dual-megaregion designation of the Houston metropolitan area airports. Despite this, their close proximity to one another would indicate strong connections, as these are the only two megaregions which touch. The Gulf Coast also has high passenger flows to two other nearby megaregions, as seen in Figure 4.11, the Piedmont, as well as the Midwest. Its flow with non-megaregion areas is comparable as well. It is the least connected to Cascadia, the Arizona Sun Corridor, and Northern California. Table C.7 summarizes the gross and standardized flows.

The standardized flows indicate the Texas Triangle as the Gulf Coast's most connected megaregion; in second, the Gulf Coast's intramega flow; and the Piedmont as its third most connected.

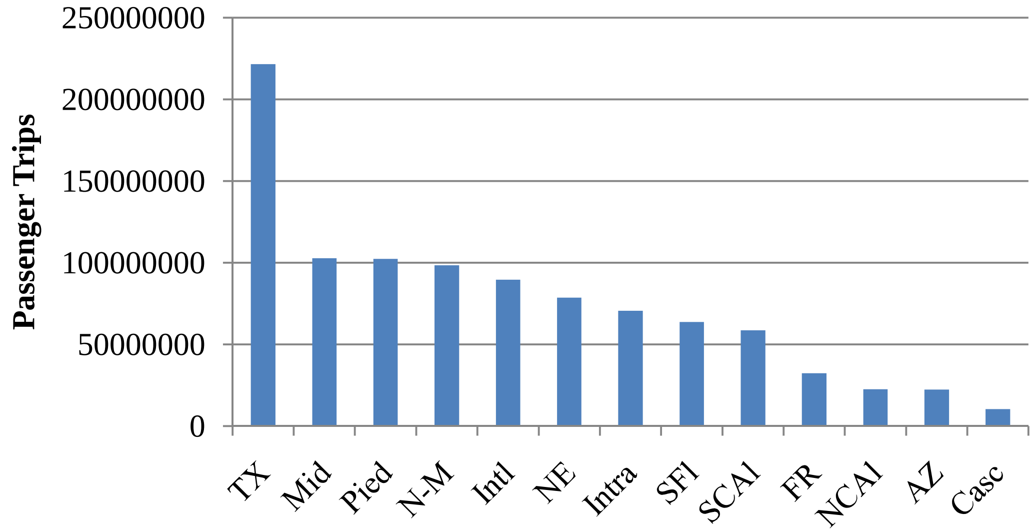

Figure 4.11: Gulf Coast Passenger Flows

By area, the Arizona Sun Corridor, non-megaregion areas, and Cascadia are the weak passenger traffic connections. By population and economic production, Northern California and the Northeast are considered a weak connection as well.

In summary, passenger flows for the Gulf Coast heavily favor nearby areas. The Gulf Coast has strong ties to the Texas Triangle, the Piedmont, and within itself. The strong intramega connection shows that the very linear megaregion encourages passenger air travel connecting its major cities. The megaregion has moderate international passenger traffic as well. Its connection to the western megaregions is weaker than to the eastern megaregions.

4.4.4.2 Freight Traffic

The Gulf Coast is one of two megaregions which is a net exporter of air freight. What makes it different from Cascadia, the other net exporter, is that the Gulf Coast only is an exporter to four areas: internationally, the Northeast, Front Range, and Arizona Sun

Corridor. The international connection though, is so much larger than the flows to other megaregions, and the difference so large, as seen in Figure 4.12, that it more than balances out the flows from other megaregions coming into the Gulf Coast. Cascadia, non-megaregion areas, and Southern Florida have the largest differences in directional flows with the Gulf Coast for megaregions with which the Gulf Coast is a net importer. Table C.8 summarizes the gross and standardized flows.

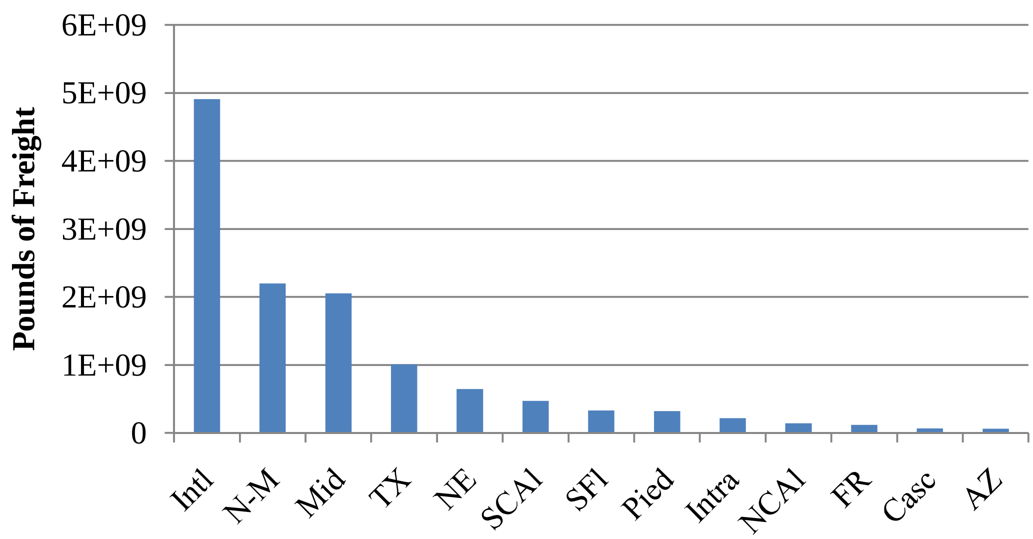

Figure 4.12: Gulf Coast Freight Flows

The three top pairings with which the Gulf Coast ships air freight are international, non-megaregion areas, and the Midwest. Texas Triangle, its conjoined megaregion is in fourth. The lowest flows are toward the western megaregions: the Arizona Sun Corridor, Cascadia, and Front Range.

Standardizing by area, population, and economic productivity, Texas Triangle and the Midwest have strong connections to the Gulf Coast. By area, the Northeast also has a strong connection to the Gulf Coast, while non-megaregion areas have a strong connection when standardizing by for population and economic productivity. The weakest connections are Cascadia, the Arizona Sun Corridor, and Northern California, and non-megaregion areas when standardizing by area.

In summary, the Gulf Coast's freight traffic is very strong internationally. Within the U.S., it is well connected to the Texas Triangle and the Midwest. Non-megaregion areas also play a strong role in the Gulf Coast's air freight. It has moderate intramega freight traffic. The Gulf Coast is a net exporter of goods, although mostly influenced by its international traffic, as it is a net importer with nine megaregions and non-megaregion areas.

4.4.5 Midwest

4.4.5.1 Passenger Traffic

The Midwest megaregion's passenger flows are highest to the Northeast, within the Midwest, and to non-megaregion areas, as seen in Figure 4.13. After these top three flow pairings, there is a group of five pairings that are just under half as large as the top three. It has low passenger flows to the Arizona Sun Corridor, the Gulf Coast, and Cascadia. Table C.9 summarizes the gross and standardized flows.

When standardizing the passenger flows, the Midwest is mostly strongly connected to itself. Its intramega flows are the highest by every standardization. In second and third consistently are the Northeast and Southern Florida. Non-megaregion areas, when standardized by area are the least connected, but not when standardized by population or economic productivity. Cascadia, the Gulf Coast, and Northern California are the least connected megaregions when flows are standardized.

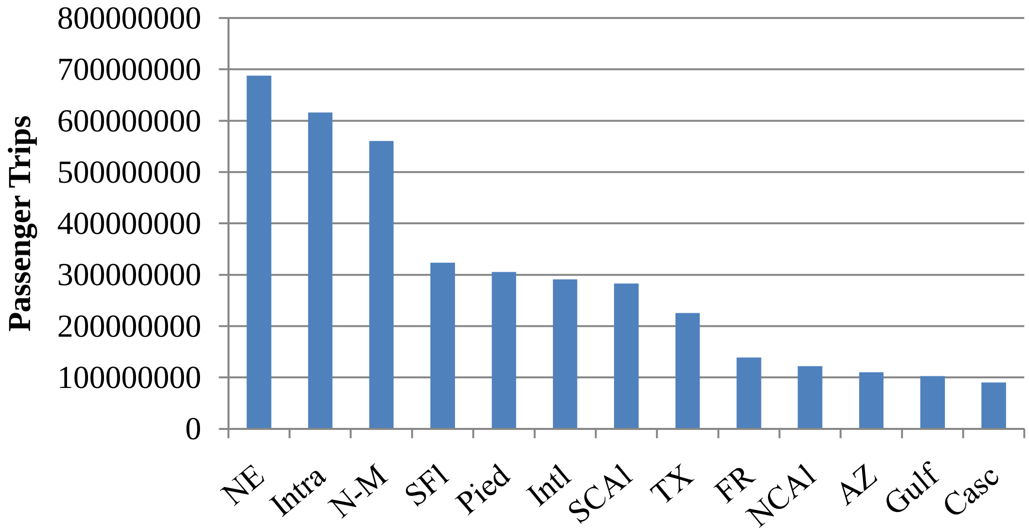

Figure 4.13: Midwest Passenger Flows

In summary, the Midwest is well tied to the Northeast and Southern Florida. It has high flows to non-megaregion areas, and moderately high international flows. Its gross flows are similar to its standardized flows, even with its intramega traffic at or near the top of both. Its least strong connections are the smaller megaregions of the Gulf Coast, Cascadia, Northern California, and the Arizona Sun Corridor.

4.4.5.2 Freight Traffic

The Midwest does not have very high international freight flows compared to other megaregions, but it is still high compared to its other pairings. As seen in Figure 4.14, it has significant freight flows to non-megaregion areas, internally as intramega flows, and to the Northeast as well. It has low air freight flows to the smaller megaregions: the Front

Range, Gulf Coast, and Arizona Sun Corridor. The Midwest exports goods to most megaregions except Southern California and Northern California. Table C.10 summarizes the gross and standardized flows.

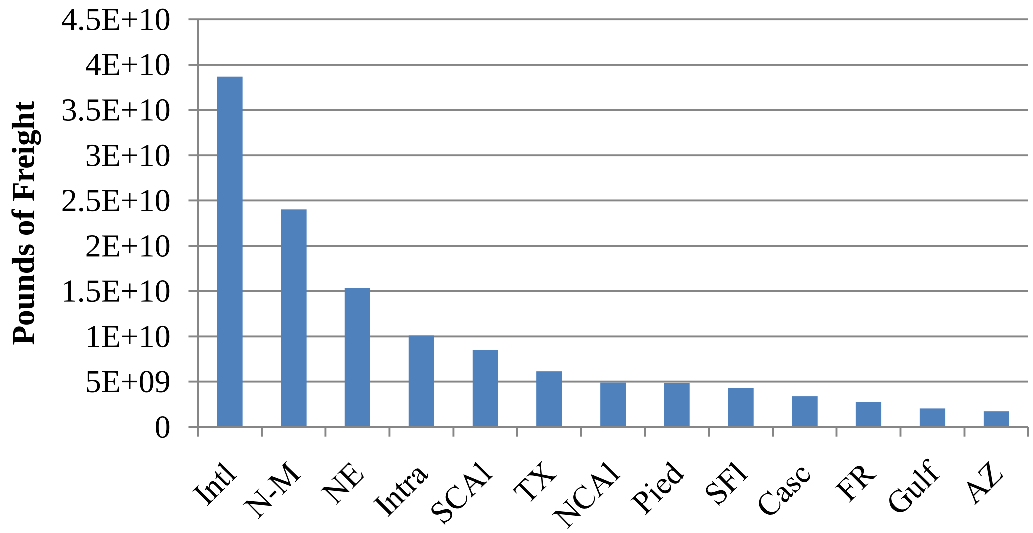

Figure 4.14: Midwest Freight Flows

Standardizing by area, the top three pairings are with the Northeast, the Midwest intramega flows, and with Southern California. It is weakly connected by area to the Arizona Sun Corridor, non-megaregion areas, and the Gulf Coast.

The Midwest's flows standardized by population and economic productivity are similar. By population its top flow is to non-megaregion areas, while by economic production its top standardized flow is its intramega movements. In third for both standardization methods is the Northeast. The Arizona Sun Corridor has the weakest standardized connection by population and economic productivity, with the Gulf Coast and Front Range just above it.

The Midwest’s air freight traffic is very strong internally to the megaregion, internationally, and to the Northeast. Its connection to non-megaregion areas is also high. The Midwest’s connections to other megaregions dwarfs that of the other areas, but especially weak with the Arizona Sun Corridor, Gulf Coast, and Front Range. Even when standardized, these smaller economies cannot compete with a large economy such as the Northeast for the Midwest’s air traffic.

4.4.6 Northeast

4.4.6.1 Passenger Traffic

The Northeast has very strong passenger connections to both the Midwest and internationally, as seen in Figure 4.15. In addition, Southern Florida is a very large market pair for the Northeast, followed by a slow drop-off in other connections. The lowest volumes are to and from the Front Range, Arizona Sun Corridor, and Cascadia. Table C.11 summarizes the gross and standardized flows.

Passenger flows for the Northeast when standardized by area show that Southern Florida is the strongest connection. The Northeast’s intramega flows are the second strongest connection, with the Piedmont in third. The weakest connection by area is with non-megaregion areas, followed by Cascadia and the Arizona Sun Corridor.

Standardized flows by population and economic productivity are similar. Southern Florida is still the top pairing for the Northeast, while the Midwest and Piedmont are also strong. The weakest connection is with Cascadia, followed by the Arizona Sun Corridor and the Gulf Coast.

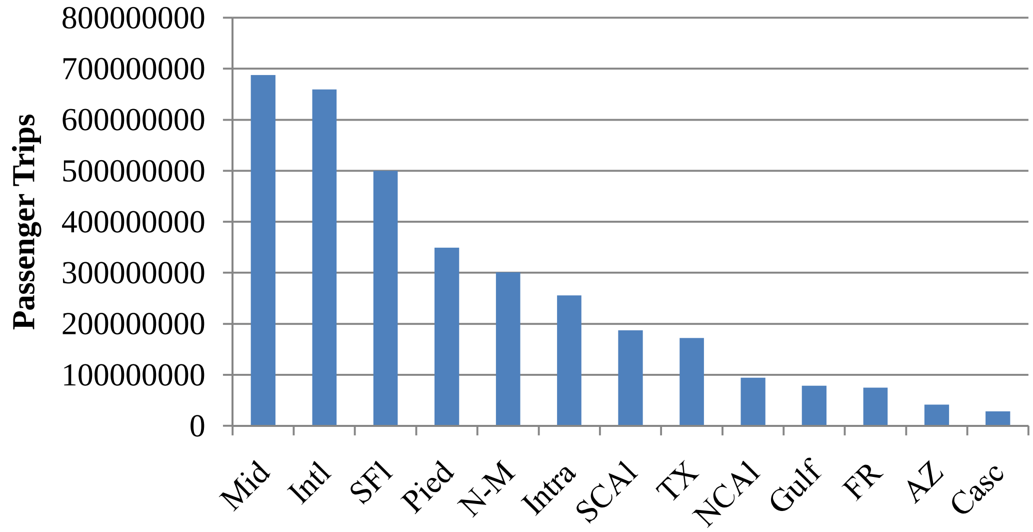

Figure 4.15: Northeast Passenger Flows

In summary, the Northeast has strong pairings with Southern Florida, the Midwest, and the Piedmont. These four eastern megaregions consistently show up at the top of each other's lists. The Northeast has very strong international connections, and also moderately large flows with the non-megaregion areas. It is the least connected with megaregions with small populations and economies spatially farther away: the Arizona Sun Corridor, Gulf Coast, and Cascadia.

4.4.6.2 Freight Traffic

The freight connection the Northeast has internationally is four times larger than what it has with any other area. As a net importer (with a 25% difference between exports and imports internationally), this part of the Northeast's air freight market is a critical piece of the Northeast freight network. As seen in Figure 4.16, the next largest flows behind the international market are the Midwest and non-megaregion areas, each over twice as large as the fourth place megaregion, Southern California. The lowest freight connections are with Arizona Sun Corridor, Cascadia, and the Front Range. Table C.12 summarizes the gross and standardized flows.

The Northeast is a net importer internationally, and with the Midwest, non-megaregion areas, Southern California, Northern California, Southern Florida, the Gulf Coast, and Cascadia. It is a net exporter with the Piedmont, Texas Triangle, Front Range, and the Arizona Sun Corridor.

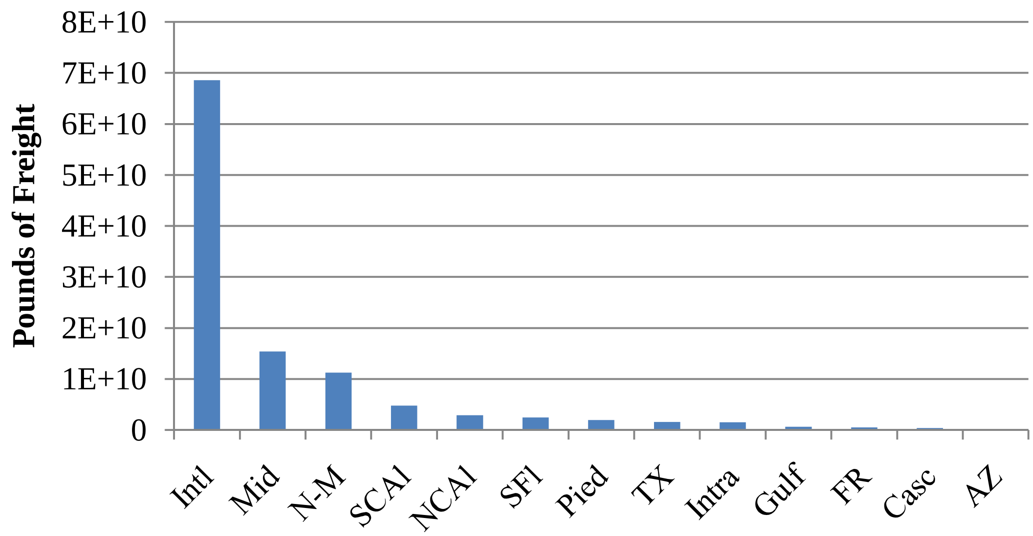

Figure 4.16: Northeast Freight Flows

With standardized flows, the Northeast's strongest connections are with the Midwest, followed by Southern California, non-megaregion areas, and Northern California. Its weakest standardized flows are with the Arizona Sun Corridor, Cascadia, and the Front Range.

In summary, the Northeast's international freight market is such a dominant part of the Northeast's air freight system that it is larger than all of the other flows combined.

Still, the Northeast has strong connections to the Midwest as well. In addition, it is well connected to non-megaregion areas, and to Southern California. It has very little connection with the non-California western megaregions: Front Range, Cascadia, and Arizona Sun Corridor. Its intramega freight flow is only moderately high.

4.4.7 Northern California

4.4.7.1 Passenger Traffic

Not surprisingly, Northern California has a very strong passenger tie with Southern California, with flows to its neighbor in-state that are larger than the next three highest flow pairs combined. Figure 4.17 shows the high flow rates between these two megaregions, with similarly sized flows for the several pairings after. The next three are to the international market, the Midwest, and Cascadia. Northern California has very low flows to Southern Florida and the Gulf Coast and low intramega flows. Table C.13 summarizes the gross and standardized flows.

Standardized flows verify the strong connection Northern California has with Southern California and Cascadia. In addition, the Arizona Sun Corridor is a strong connection when standardized by population and economic productivity. By area, Northern California's intramega flows are strong.

North California's weak connections are revealed through standardized flows. The weak connections are with the Gulf Coast and Southern Florida when standardized by all three methods. By area, in addition, non-megaregion areas are a weaker connection, but by population and economic productivity, Northern California's connection with the Piedmont is considered one of the weaker flows.

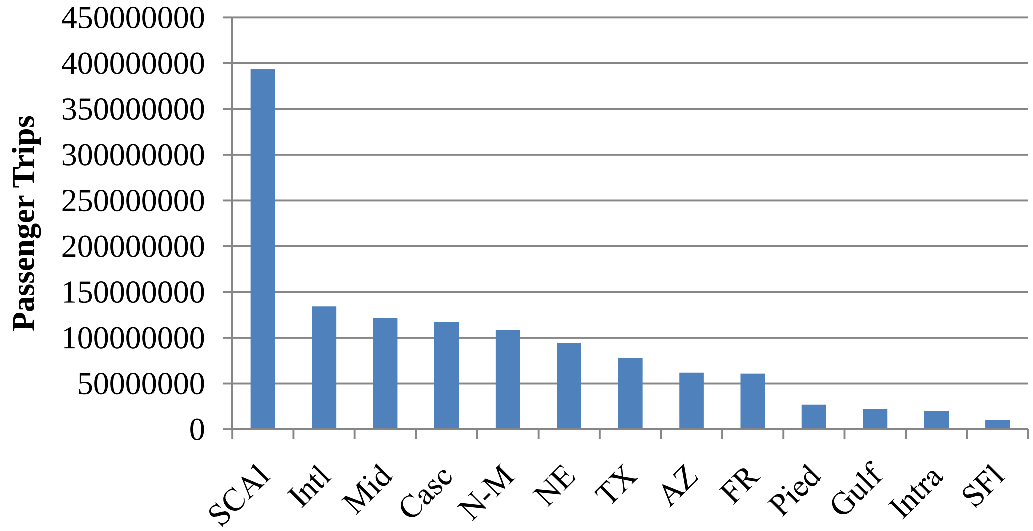

Figure 4.17: Northern California Passenger Flows

In summary, Northern California is strongly connected to the western megaregions of Southern California, Cascadia, and the Arizona Sun Corridor. The megaregion has a strong presence in international passenger traffic. Due to its small megaregion size, there are very little internal flows, but the flows that do exist are relatively high for its size. Northern California is not well connected to the southeastern megaregions of Southern Florida, Piedmont, and the Gulf Coast.

4.4.7.2 Freight Traffic

International freight traffic is the number one pairing for Northern California, being a net importer from the international market. As seen in Figure 4.18, there is a small drop in magnitude after international flows, followed by non-megaregion areas and the Midwest. Northern California has low air freight flows with the Gulf Coast, Southern Florida, and within the Northern California megaregion. Although Northern California only imports from two megaregions, Southern Florida and Southern California, it is still a net importer as a whole because of the immense volume of international flows sending air freight to Northern California. Table C.14 summarizes the gross and standardized flows.

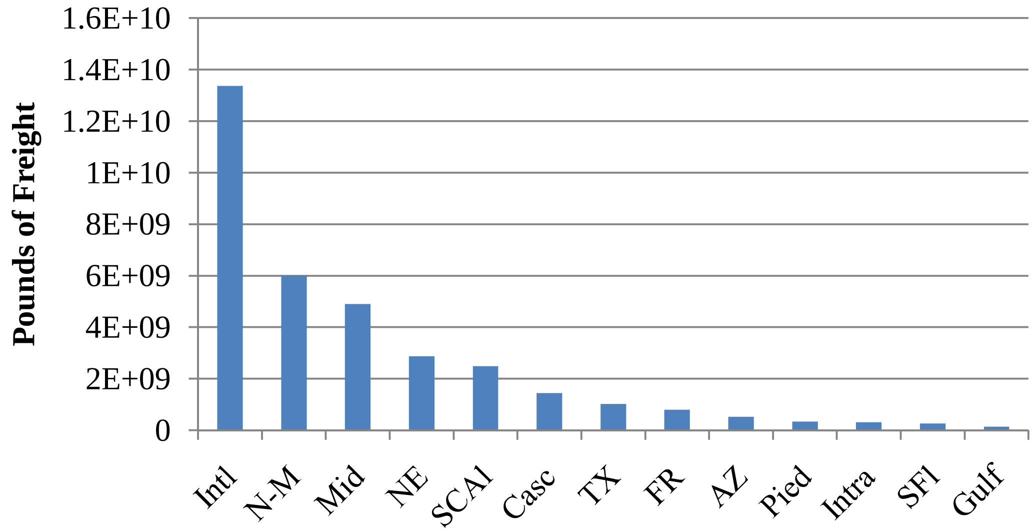

Figure 4.18: Northern California Freight Flows

Despite having a low magnitude of intramega flows, when standardized by area, the small size of the Northern California megaregion causes this flow to be the top ranked. Other top flows by area are with Southern California and the Midwest. Low connections exist with the Gulf Coast, non-megaregion areas, and Southern Florida when standardizing by area.

When standardizing by population, Northern California's top connections are with the Midwest, Cascadia, and Southern California. Its weakest connections are with the Gulf Coast, Southern Florida, and Piedmont.

Standardizing by economic production, Northern California is most closely tied to the Midwest, non-megaregion areas, and Cascadia. It is the least tied with the Gulf Coast, Southern Florida, and the Piedmont.

Overall, Northern California's air freight is dominated by international freight traffic, but it also has close ties with the Midwest, Southern California, and Cascadia. It also has a strong connection with non-megaregion areas. It has low intramega freight flows, but when standardized by area these flows are the top ranked for the megaregion. The megaregion's weakest flows are with the megaregions in the southeastern U.S. – Southern Florida, the Gulf Coast, and the Piedmont. It is a net importing megaregion, although it exports to nine of eleven megaregions, with its main imports coming internationally.

4.4.8 Piedmont

4.4.8.1 Passenger Traffic The top four pairings with the Piedmont are very similar in magnitude. The Piedmont's strongest passenger connections are to its fellow eastern megaregions of the Northeast, Southern Florida, and Midwest. It also has high flows to non-megaregion areas, as seen in Figure 4.19. There is a drop-off after the top four pairings, with Texas Triangle being less than half of the Midwest. The lowest flows to and from the Piedmont are with Cascadia, the Arizona Sun Corridor, and Northern California. Table C.15 summarizes the gross and standardized flows.

Standardizing the Piedmont's passenger flows shows a very strong connection to Southern Florida, highest in all three standardization variables. The Piedmont is also revealed to have a strong internal network, as its intramega flows are the second highest by population and economic productivity and third highest by area. The Northeast is also a strong connection by area and population, and the Midwest by economic productivity.

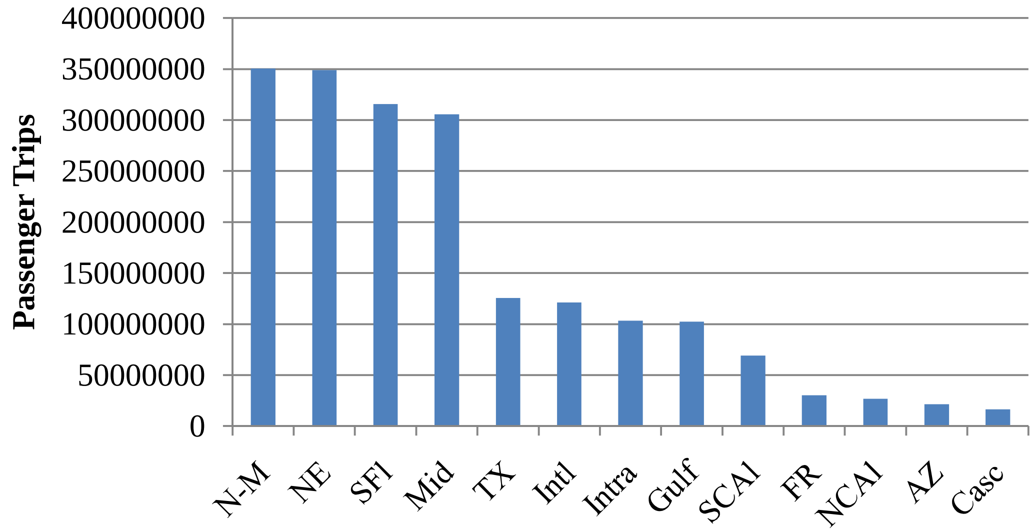

Figure 4.19: Piedmont Passenger Flows

The weak connections for the Piedmont, as observed by examining standardized flows, are Cascadia, the Arizona Sun Corridor, and Northern California. Its non-megaregion area pairing is low when standardized by area.

In summary, the Piedmont's passenger connections are strong to its eastern megaregion neighbors. Its closest connection is Southern Florida, followed by the Northeast and Midwest. It has weak connections with the western megaregions.

4.4.8.2 Freight Traffic

The Piedmont's largest freight flows are with the international market, followed by the Midwest and non-megaregion areas, as seen in Figure 4.20. As a whole, the Piedmont is a net importer of goods, and only exports to the Texas Triangle, Gulf Coast, Front Range, and Arizona Sun Corridor, some of its smallest air freight flow pairs. It also has low intramega freight traffic. Table C.16 summarizes the gross and standardized flows.

The Midwest and Southern Florida are the two strongest connections the Piedmont has in freight flows, first and second, respectively, in all standardizations. Standardized by area, the Piedmont's pairing with the Northeast is near the top, but by population and economic productivity the pairing with non-megaregion areas is strong. The Piedmont has its weakest connections in air freight with the Arizona Sun Corridor and the Front Range.

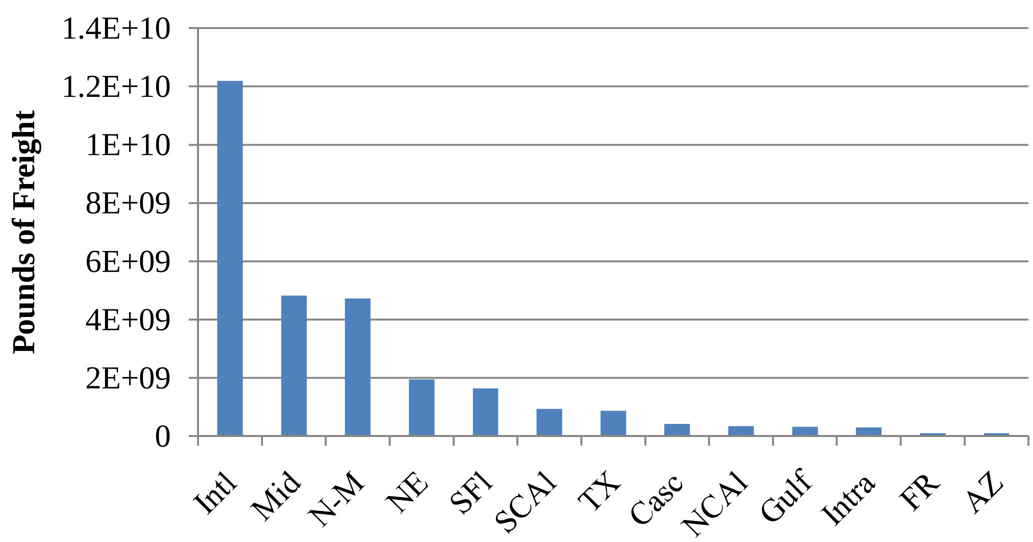

Figure 4.20: Piedmont Freight Flows

In summary, the Piedmont's air freight flows consist of strong connections internationally as well as to the eastern megaregions such as the Midwest and Southern Florida. Its non-megaregion area connection is strong as well, even by standardized flows. Western megaregions have weaker flows to the Piedmont, but it is with its weaker connections that the Piedmont exports goods.

4.4.9 Southern California

4.4.9.1 Passenger Traffic

Southern California's primary passenger markets are with Northern California, the international market, and the Midwest. As seen in Figure 4.21 there is a slow decline in flows from the busiest to smallest flows. Its lowest flows are with the Piedmont, Gulf Coast, and Southern Florida. Table C.17 summarizes the gross and standardized flows.

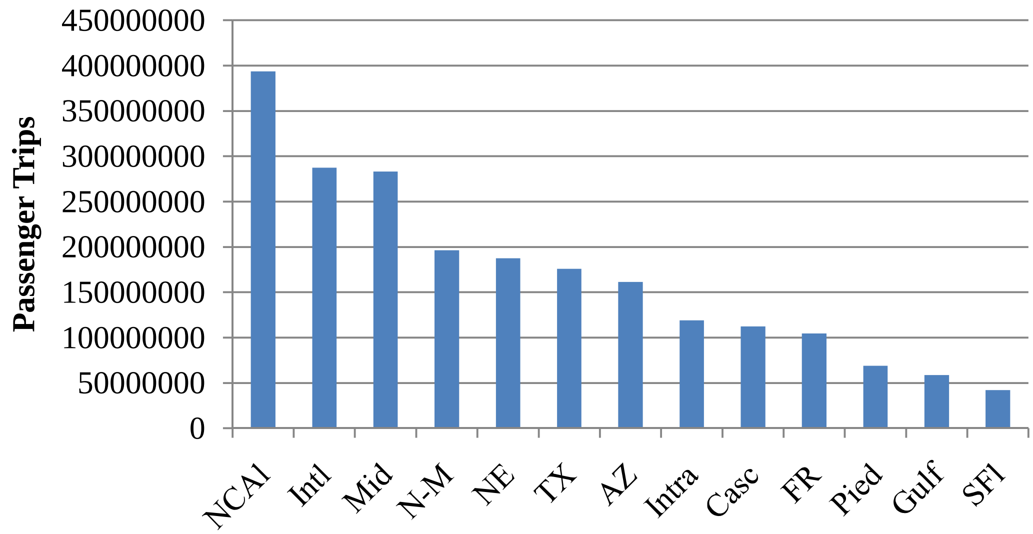

Figure 4.21: Southern California Passenger Flows

By area, Southern California's flows are greatest with Northern California and the Northeast, along with its intramega flows. It has weaker connections with non-megaregion areas, Southern Florida, and the Gulf Coast.

Southern California's standardized flows by area and population are similar in rankings. Northern California has the greatest ties, with the Arizona Sun Corridor in second. Southern California's intramega flows are the third highest. Southern Florida, the Gulf Coast, and the Piedmont have the weakest flows with Southern California.

In summary, passenger connections with Southern California are strong to its neighbors of Northern California and the Arizona Sun Corridor. It has high traffic levels to its nearest neighbors. In addition, the megaregion has high flows internationally but also internally as intramega flows. It is the least tied to the southeastern megaregions of Southern Florida, the Gulf Coast, and the Piedmont.

4.4.9.2 Freight Traffic

International freight is very dominant in Southern California, almost equaling the magnitude of all other freight flows elsewhere combined. It is a net importer with a 33% difference in exports and imports. The second highest flow is to non-megaregion areas, one-third the magnitude of international flows, followed by the Midwest, as seen in Figure 4.22. The lowest flows are intramega, to the Gulf Coast, and to the Arizona Sun Corridor. Table C.18 summarizes the gross and standardized flows.

Southern California is a net importer, influenced strongly by the flows it has with the international market. To the U.S. and its megaregions, it is a net importer from non-megaregion areas, Southern Florida, and the Front Range. To all other megaregions it is a net exporter.

Standardized by area, Southern California's strongest flows are to the Northeast but also to the Midwest and Northern California. It has weak flows by area to the Gulf Coast and non-megaregion areas, as well as its intramega flows.

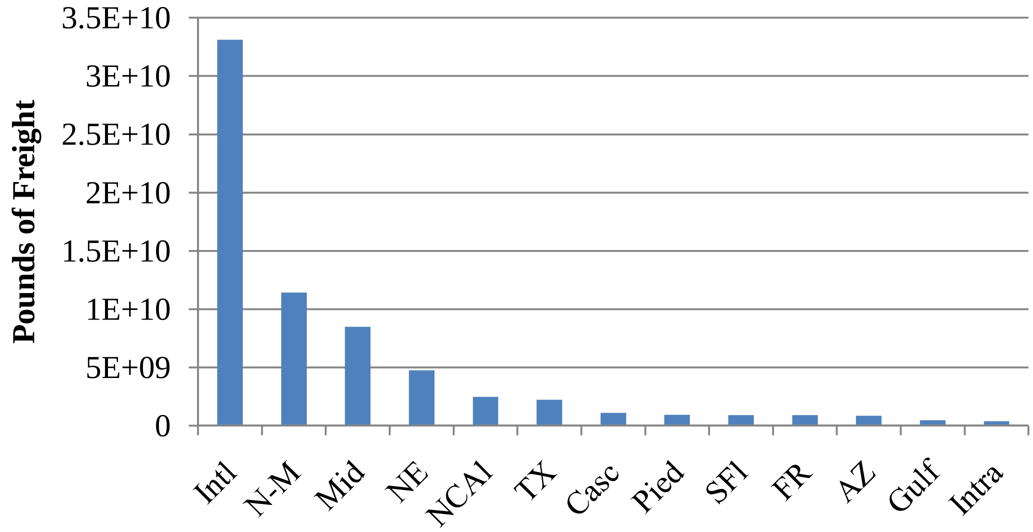

Figure 4.22: Southern California Freight Flows

The standardizations of flows by population and economic productivity show that Southern California's strongest ties are the Midwest, Northern California, and non-megaregion areas. It has weak connections with the Gulf Coast and Southern Florida, as well as having weak intramega flows.

In summary, Southern California has one of the strongest international connections for air freight of all the U.S. megaregions. It is tied to Northern California as its in-state neighboring megaregion, but also across the country to the Midwest. It has a high volume and significant standardized flow to non-megaregion areas. Southern California is weakly tied by air freight to the southeastern U.S., with low flows to the Gulf Coast and Southern Florida. Southern California's intramega network is small compared to the size, population, and economic productivity of the megaregion.

4.4.10 Southern Florida

4.4.10.1 Passenger Traffic

Southern Florida's top connection is with the Northeast, but has relatively significant and equal flows with the international market, the Midwest, and Piedmont. There is a drop-off in magnitude after the Piedmont, as seen in Figure 4.23. The lowest flows are to Northern California, the Arizona Sun Corridor, and Cascadia. Table C.19 summarizes the gross and standardized flows.

Standardized flows by area reveal a strong connection to the Northeast and Piedmont megaregions. In addition, Southern Florida has a strong intramega flow by area. The weakest connections by area are to Cascadia, non-megaregion areas, and the Arizona Sun Corridor.

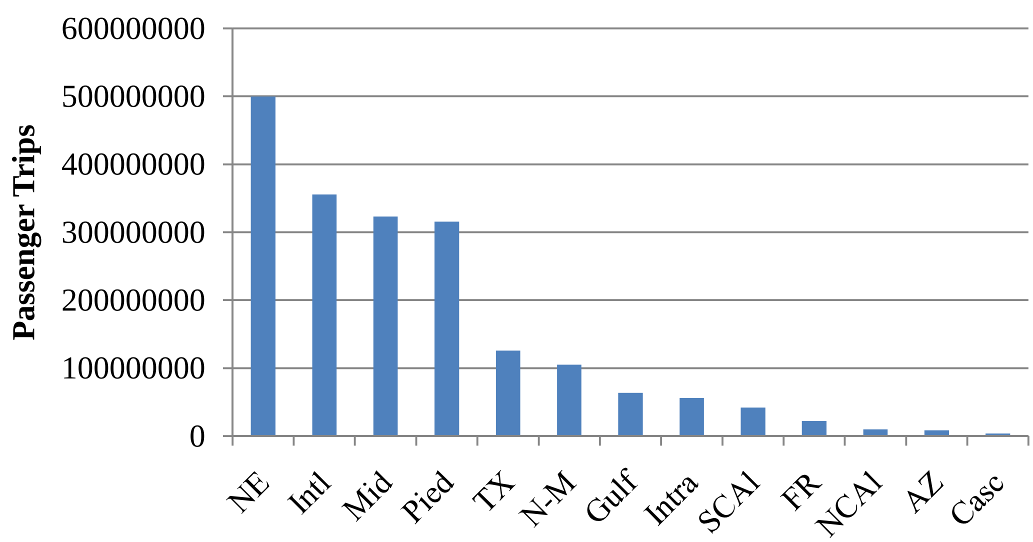

Figure 4.23: Southern Florida Passenger Flows

Flows standardized by population and economic productivity are similar. The top connections for Southern Florida are to the Piedmont, Northeast, and Midwest. The weakest flows are to Cascadia, Northern California, and the Arizona Sun Corridor.

Southern Florida is one of the four eastern megaregions that have strong connections in passenger traffic, and thus flows to and from the Northeast, Piedmont, and the Midwest show up prominently even in standardizations. Its international connection is strong as well. Southern Florida is not well tied to the western megaregions.

4.4.10.2 Freight Traffic

International freight's dominance over Southern Florida's air flows is clear. Nearly three times as much freight is destined to or coming from the international market than all other combined flows into and out of Southern Florida. Compared to international flows, as seen in Figure 4.24, the remaining pairings seem small. Non-megaregion areas, nearly nine times smaller than the international flows, are the second highest, followed by the Midwest. The weakest air freight connections are with the Arizona Sun Corridor, Front Range, and Cascadia. Due to the high volume of the international traffic, Southern Florida is a net importer megaregion. It does, however, act as a net exporter to seven of the megaregions, and is a net importer to non-megaregion areas, Midwest, Texas Triangle, and Cascadia. Table C.20 summarizes the gross and standardized flows.

The standardized flows reveal strong freight connections to the Midwest, Piedmont, non-megaregion areas, and the Northeast. Weaker flows are seen to be with the Arizona Sun Corridor, the Front Range, and Cascadia.

Southern Florida's freight flows center around its international connections. The flows to the U.S. are to nearby megaregions in the east: the Midwest, Piedmont, and the

Northeast. It also has high gross and standardized flows to non-megaregion areas. Southern Florida has weaker freight ties with western megaregions, and has moderately high intramega freight flows.

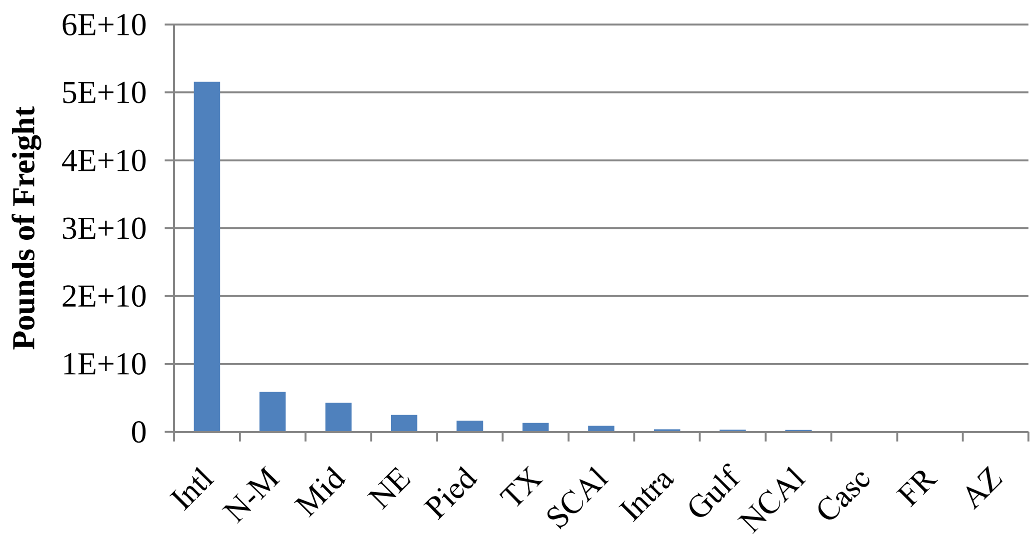

Figure 4.24: Southern Florida Freight Flows

4.4.11 Texas Triangle

4.4.11.1 Passenger Traffic

The Texas Triangle's top flow is to non-megaregion areas, but the top flows after decline slowly, as seen in Figure 4.25. The second and third largest flows are to the Midwest and the Gulf Coast, with its intramega flows in fourth. Its smallest flows are with Northern California, the Arizona Sun Corridor, and Cascadia. Table C.21 summarizes the gross and standardized flows.

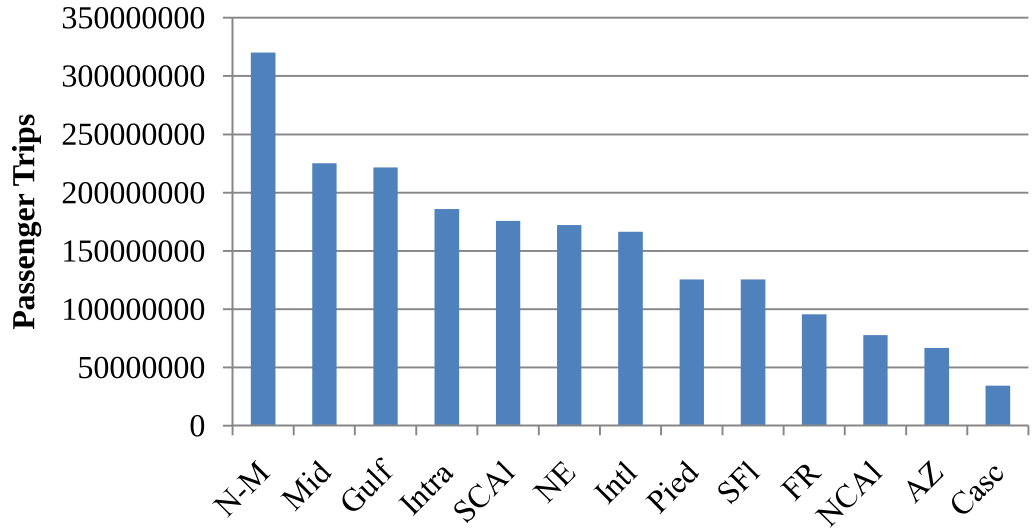

Figure 4.25: Texas Triangle Passenger Flows

The Texas Triangle's standardized flows reveal that its intramega flows are very strong compared to other pairings. Behind its intramega flows are those with the Gulf Coast, Southern California (by area and population), and the Piedmont (by economic productivity). Its weaker flows pairings by area are with non-megaregion areas, Cascadia, and the Arizona Sun Corridor. By population and economic productivity the weakest flows are with Cascadia, the Northeast, and Northern California.

Overall, the Texas Triangle has one of the strongest intramega passenger flow levels of any megaregion. It is well connected to the adjacent Gulf Coast and with Southern California. In addition, its non-megaregion area connection by gross volume is its largest flow. Texas Triangle's weakest flows are with Cascadia and Northern California, as well as with the Northeast.

4.4.11.2 Freight Traffic

The largest freight flow for the Texas Triangle is its international freight connection, about twice as large as the next two largest flows, as seen in Figure 4.26, to the Midwest and non-megaregion areas. The weakest flows are to the Front Range, Arizona Sun Corridor, and Cascadia. As a whole, the Texas Triangle is a net importer. It only is a net exporter with Southern Florida, the Gulf Coast, Front Range, and the Arizona Sun Corridor. Table C.22 summarizes the gross and standardized flows.

Standardized freight flows for the Texas Triangle show that the Midwest is the top pairing for freight movement. Southern California and non-megaregion areas are also a significant pair, although non-megaregion areas are considered weak when standardized by area. Weak standardized freight pairings exist with Cascadia, the Arizona Sun Corridor, and the Front Range.

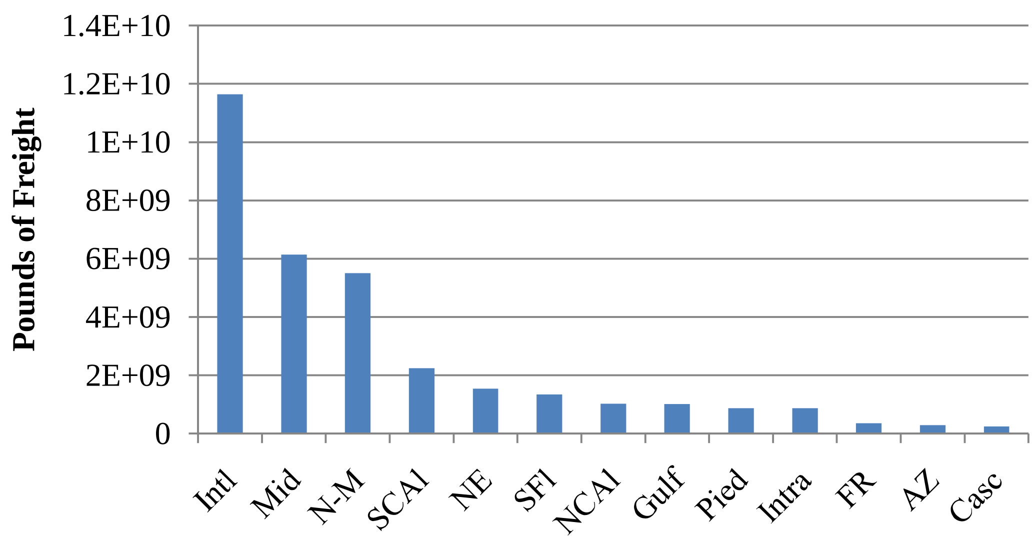

Figure 4.26: Texas Triangle Freight Flows

The Texas Triangle's strong international freight connection is dominant, but the megaregion also has significant flows with the Midwest, Southern California, and non-megaregion areas. The weaker connections are with the western non-California megaregions.

4.4.12 Summary

The collection of each of the megaregions' unique set of flow pairs for passenger and freight traffic have identifiable trends. Through an examination of each of the megaregions' flows, it was possible to identify the character of each megaregion's networks. The purpose of this summary is to gather what was learned about each megaregion and discuss these findings.

If one were to combine all of the megaregions, intermega flows would be the top pairing for all of the megaregions. Consisting of the majority of the country's metropolitan areas, population, and economic production, megaregion to megaregion travel is naturally the largest portion of the U.S. passenger travel market. The proportion of megaregions' total flows that were intermega flows ranged from 53% (Midwest) to 84% (Arizona).

Overall, it is seen that megaregions generally have their greatest passenger connections with the megaregions that are nearest to them, and have similar weak flows to other parts of the country. The four eastern megaregions, the Midwest, Northeast, Piedmont, and Southern Florida, all have high passenger flows to each other over other megaregions in the central or western part of the country. Western megaregions often have their highest flows to other western megaregions, and have weak flows to the southeastern U.S. For any given megaregion, two of its top three standardized passenger flows were to the megaregions nearest to it geographically or its intramega flow.

When comparing intermega, intramega, non-megaregion, and international flows, the second most prominent pairing after intermega flows is different among the megaregions. Three megaregions had intramega traffic as the second highest, the case for Gulf Coast, Midwest, and Texas Triangle. The second highest pairing for four megaregions was non-megaregion areas, the case for Arizona Sun Corridor, Cascadia, Front Range, and Piedmont. These four megaregions are the four smallest megaregions by land area. The second most prominent pairing for four megaregions was the internationals market, the case for the Northeast, Northern California, Southern California, and Southern Florida. These are four of the top six in terms of GMP.

Megaregion size plays a strong role in deciding the magnitude of its intramega flows. This makes sense practically, as a larger megaregion is more likely to require air travel for passengers to reach its extents. Thus, it is not surprising that the megaregions with the strongest intramega flows are the Midwest, Texas Triangle, and Southern California, the three largest megaregions. Also with significant intramega flows are the Gulf Coast and the Front Range, both very linear megaregions. By gross volumes, the four megaregions that have intramega traffic as one of its top two megaregion destinations are all in the top six in size.

Freight traffic is strongly oriented towards the international market. Of the eleven megaregions, only three megaregions did not have their pairing with the international market as their top flow. One of these, Cascadia, had international flows as their second highest pairing, just behind non-megaregion areas. That leaves two megaregions that do not have a prominent international flow pairing: the Arizona Sun Corridor and the Front Range. These two megaregions are far inland, requiring air freight to be transported farther at high costs to these megaregions. In addition, they have small populations and fewer major cities than the other megaregions. In conjunction with having newer, less established economies, it is not surprising that they lack in the international freight business. The remaining megaregions have international freight as their highest flow due to their proximity to the coasts (less distance for air freight to have to be shipped), and due to established network economies more tuned into other world cities and markets.

Nine of the eleven megaregions had the same three gross volume pairs as their top flows. Already mentioned was international flows, but non-megaregion flows and flows with the Midwest are also very high. For the two megaregions which do not have high international flows, the Midwest and non-megaregion areas are their top two flow pairs. By gross volumes, all of these are large in freight flows due to the large markets (the international, non-megaregion area, and Midwest markets) they represent. Even though they may not be high when standardized, airports within megaregions still must handle such high volumes of freight to these areas.

The Midwest is interesting in particular, because it exists with high flows to all megaregions in freight, while it did not in passenger traffic. This detail leads to an important finding. While there is a spatial element to where the greatest connections are for passenger traffic (nearby megaregions have higher flow pairs), freight traffic's spatial relationship is less clear. Many megaregions in fact have high standardized flows, not just high gross volumes, within the U.S. to the Midwest and non-megaregion areas.

Although not always at the top of gross volumes, the California megaregions are often one of the top standardized flows, even for the Northeast across the country. There are clear ties to the west coast in terms of air freight, and the only megaregions that are not associated with the west coast through air freight are the three southeastern megaregions: the Gulf Coast, Piedmont, and Southern Florida. The Gulf Coast is tied strongly to the Texas Triangle, while the latter two are strongly tied to each other.

One aspect of the freight traffic that cannot be ignored is the prominence of freight hubs in their network, as compared to passenger hubs in their networks. Much of the freight traffic, even in a set of market data, goes through the major freight hubs of the major freight carries: UPS and FedEx. Thus, a brief examination of the top airport freight flows in the country reveals many flows which originate in or are destined for UPS's primary U.S. hub in Louisville, Kentucky (SDF), or FedEx's primary U.S. hub in Memphis, Tennessee (MEM). This has a large effect on the distribution of flows to the areas in the study. SDF is located in the Midwest megaregion and MEM is within the non-megaregion area. Appropriately, these two areas are part of the top freight pairings nationwide. Although it does not tell the whole story, it has a mentionable effect on the results.

4.5 Individual Megaregions: Intramega Flows

The flows within a megaregion are telling of how significant the connections between the megaregion's cities are. This connection gives insight into the role of air travel for the passengers and freight of that megaregion. Spatially looking at each megaregion's passenger and freight flows helps reveal how the size and shape of a megaregion relates to its population and economic productivity. From that synthesis, it is possible to draw out how air travel plays a role in moving people and goods within a megaregion.

Two summary tables are provided in Tables 4.21 and 4.22 for passenger and freight traffic, respectively. The tables are each ranked by gross volumes, but provide standardizations by area, population, and economic productivity.

Table 4.21: Intramega Passenger Flow Summary

Megaregion	Gross (trips)	Trips per sq mi	Trips per capita	Trips per $ trillion GMP
Midwest	616259829	3006	11.5	297.3
Northeast	255887384	4152	5.2	98.8
Texas Triangle	185872799	2193	11.5	227.2
Southern California	119118232	1925	5.4	114.9
Piedmont	103299958	1734	7.0	212.6
Gulf Coast	70666029	1222	6.0	134.9
Southern Florida	55891075	1441	3.8	91.9
Cascadia	22959605	485	3.1	68.1
Front Range	20658751	364	4.4	90.2
Northern California	20130096	418	1.6	32.3
Arizona Sun Corridor	10334221	212	2.3	54.1

The top intramega flows for passenger traffic are in the Midwest, Northeast, Texas Triangle, and Southern California. These are the four largest megaregions by population, economic productivity, and land area. The Midwest and Texas Triangle, compared to the other two, have much more active intramega passenger traffic as their standardization by economic productivity and population are greater than the Northeast and Southern California. The Northeast, however, is the most active megaregion in passenger travel for its size. Although not at the top for gross volumes, the Piedmont and

Gulf Coast megaregions are very active for the size of their economy and population, third and fourth on the list, respectively, in both of these standardizations.

Table 4.22: Intramega Freight Flow Summary

Megaregion	Gross (lbs of freight)	Freight per sq mi	Freight per capita	Freight per $ trillion GMP
Midwest	10101634112	49269	187.9	4873.0
Northeast	1530860378	24838	30.9	590.8
Texas Triangle	873741146	10307	54.2	1068.1
Southern Florida	396491414	10223	27.0	652.1
Southern California	388561448	6281	17.8	374.7
Northern California	316494097	6570	24.9	508.0
Piedmont	303227302	5089	20.4	623.9
Cascadia	299287420	6322	40.4	888.1
Gulf Coast	216749252	3748	18.5	413.6
Front Range	55143624	972	11.6	240.8
Arizona Sun Corridor	53962549	1106	11.9	282.5

Northern California is the weakest megaregion for intramega traffic. Despite having a moderately high population, area, and economic productivity, its intramega traffic is near the bottom of the list.

The Front Range and Arizona Sun Corridor, on the other hand, have smaller economies, areas, and populations, and accordingly have some two of the smallest intramega flows. How they differ though is that the Front Range greatly exceeds the Arizona Sun Corridor in standardized flows.

Freight traffic's rankings are skewed slightly by the dominance of the Midwest. Due to the presence of UPS's freight hub, the Midwest's intramega freight flows are an order of magnitude larger than the rest of the megaregions, with the Northeast being the closest, over six times smaller. It is reasonable that even without the UPS hub, the Midwest would be the top megaregion, as it was for passenger traffic. Behind the Midwest still is the Northeast, which has intramega freight flows twice as large as the third place megaregion, the Texas Triangle. It is then a dropoff to the smaller intramega freight flows of Southern Florida, Southern California, and Northern California. Of these top megaregions in intramega flows, apart from the dominant Midwest, the Texas Triangle stands above the rest with high standardized flows by population and economic productivity. One must look further down the list though for the next greatest in these two categories, as the Cascadia's smaller intramega flow network are quite large for the size of its population and economic productivity.

Southern California, in fact, has relatively weak intramega freight traffic. Its standardized flows by economic productivity and population put it just above the two weakest freight systems, the Front Range and the Arizona Sun Corridor, and just behind the Gulf Coast.

The size of a megaregion certainly has a role to play in its intramega passenger and freight traffic, but slight shifts in the ordering of megaregions likely has some effect from the number and distribution of airports in a megaregion, the spread of the largest metropolitan areas, and geography.

The following sections describe each megaregion's intramega flows. Maps are provided to show where airplanes travel amongst each megaregion's airports. All of the passenger flow maps have the same scales for the passenger flows, measured in trips. Similarly, all of the freight flow maps have the same scales for the freight flows, measured in pounds of freight. The color scales were determined based on the largest intramega flows in all the megaregions: 20 million trips was chosen as the largest bin for passenger flows, and 100 million pounds was chosen as the largest bin for freight flows.

In addition, the flow scales of passenger and freight movements are proportional. A similarly colored freight flow line, in pounds, is five times the value of a passenger flow line, in trips. This provides for a comparison between passenger and freight maps in terms of the magnitudes of flows between an airport pair. For example, on a megaregion's passenger flow map, a pair's line is red, while on the megaregion's freight flow map that same pair's line is orange. One can identify that the freight flows between the pair of airports are relatively more active, as compared to the greatest flows nationwide, than the passenger flows.

4.5.1 Arizona Sun Corridor

4.5.1.1 Passenger Traffic

The intramega passenger system for the Arizona Sun Corridor is almost entirely focused on passenger traffic between Phoenix and Tucson, the megaregion's two largest metropolitan areas, and the only two hub airports in the megaregion. A map of the passenger flows is shown in Figure 4.27. Non-primary airports in the Arizona Sun Corridor generally only had passenger flows to either PHX or TUS. It is clear that the megaregion's intramega passenger air traffic is a dyad.

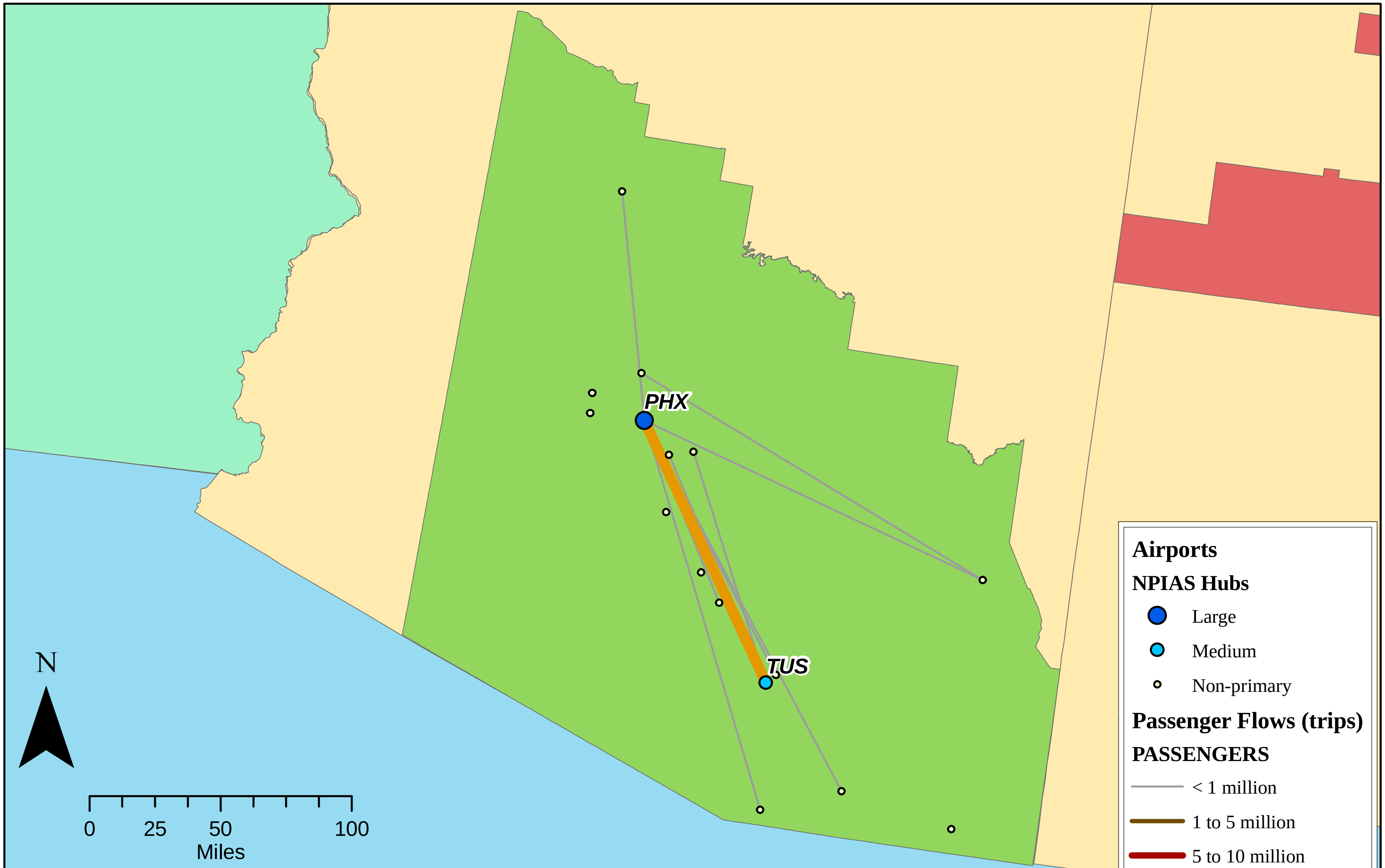

Figure 4.27: Arizona Sun Corridor Intramega Passenger Flows

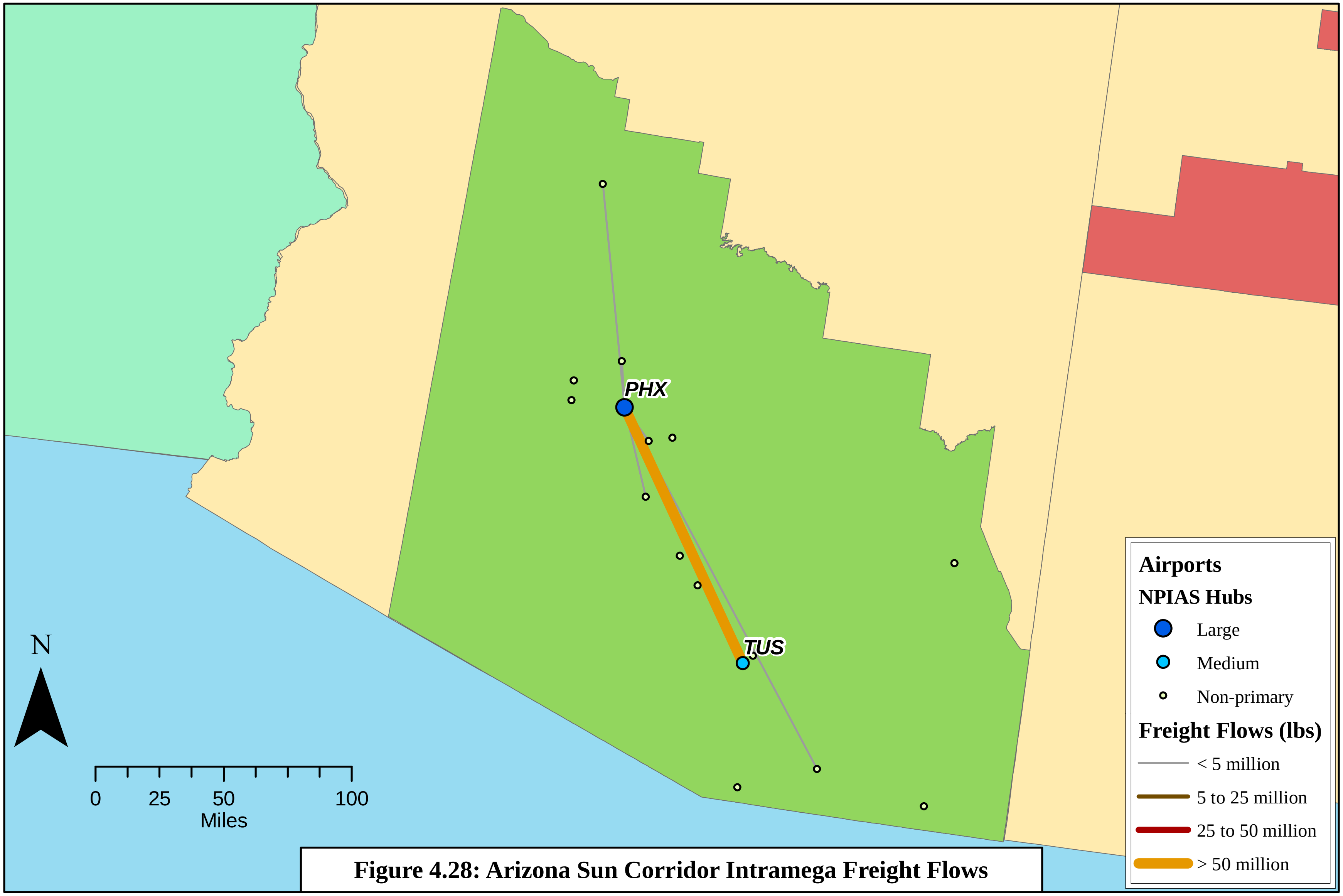

Figure 4.28: Arizona Sun Corridor Intramega Freight Flows

4.5.1.2 Freight Traffic

Phoenix and Tucson make up nearly the entire Arizona Sun Corridor intramega air freight market, as seen in Figure 4.28. There are a few non-primary airports which had very light freight flows to the two hub airports. It is clear that the megaregion's intramega freight traffic is a dyad.

4.5.2 Cascadia

4.5.2.1 Passenger Traffic

The Cascadia megaregion has a passenger network that is dominated by its two largest metropolitan areas, Seattle and Portland. Over 10 million passengers traveled between SEA and PDX, , and all other significant flows had one of these airports as an endpoint, as seen in Figure 4.29. EUG is the only city to have significant flows greater than one million passenger trips to SEA and PDX. Many non-primary and non-hub airports have flows between each other, especially along the Pacific coastline. It is clear, though, that the Cascadia megaregion's intramega passenger traffic is a dyad.

4.5.2.2 Freight Traffic

Freight traffic in Cascadia is dominated by the two metropolitan areas of Seattle and Portland. A map of the intramega freight network is show in Figure 4.30. The freight flows in Seattle, however, are produced at and attracted from not only SEA, but also to and from Boeing Field (BFI), Seattle's primary air freight airport and the location of Boeing's final preparation facilities. Within Cascadia, BFI's primary freight flow is with PDX, while SEA has significant freight flows with several non-hub airports. Cascadia's intramega freight network makes use of non-primary airports much

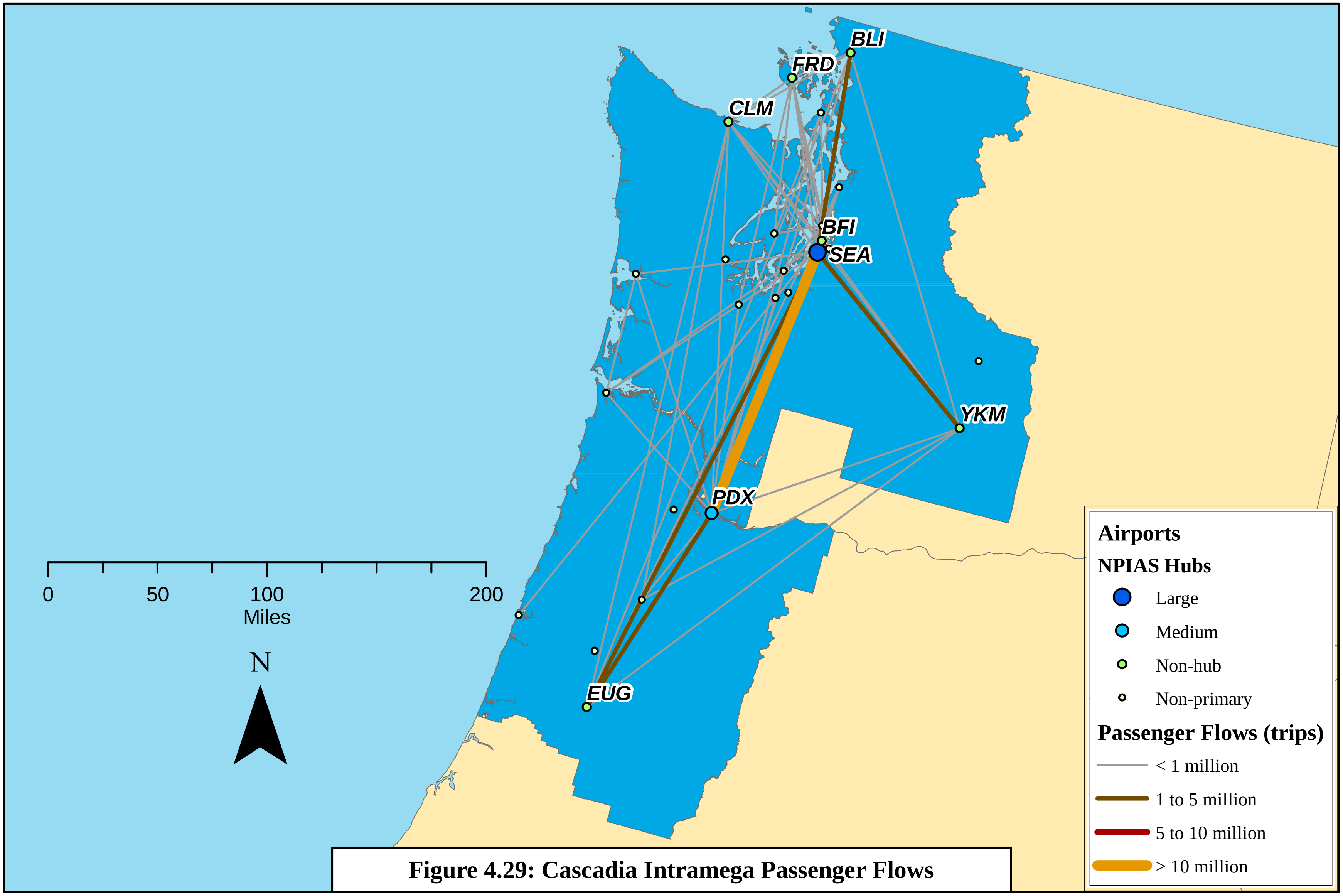

Figure 4.29: Cascadia Intramega Passenger Flows

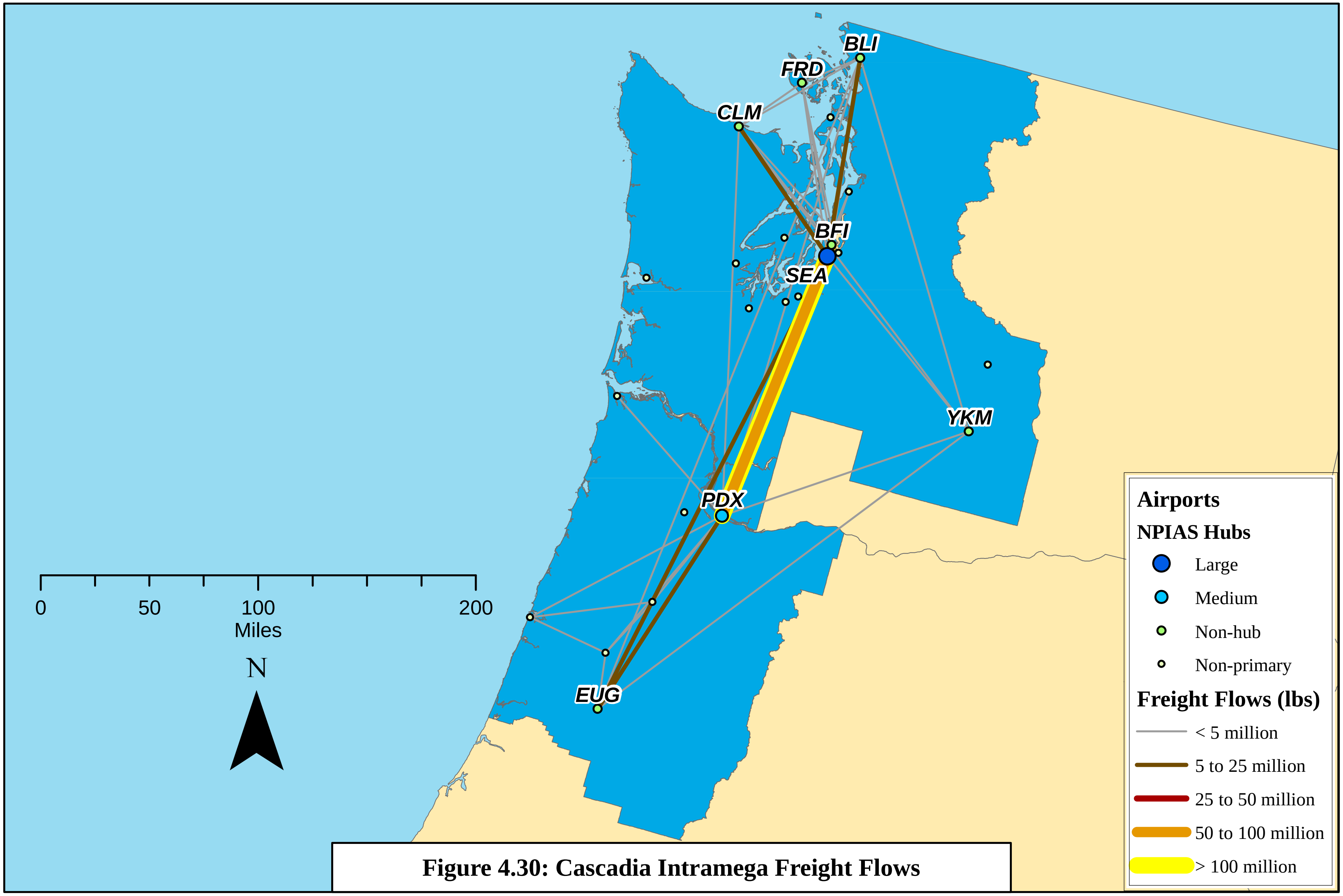

Figure 4.30: Cascadia Intramega Freight Flows

less than the passenger network. EUG is the only non-hub airport with significant flows to both PDX and SEA. Cascadia's intramega freight network is a dyad.

4.5.3 Front Range

4.5.3.1 Passenger Traffic

Passenger travel in the Front Range megaregion is primarily between the Denver and Albuquerque metropolitan areas. Within the intramega passenger system there are also significant flows from Denver to Eagle and Colorado Springs, Colorado, as seen in Figure 4.31. The flow between Denver and Colorado Springs, is actually just under 90% of the flow Denver has with Albuquerque. The non-hub and non-primary airports in the megaregion have low flows to the megaregion's larger airports, and there are connections between many of the smaller airports. Overall, though, Denver is the centerpoint of the megaregion, and the intramega passenger flow network is clearly hub-focused.

4.5.3.2 Freight Traffic

The Front Range's intramega air freight network is not as prominent as the passenger network, with the major flow between the two main Front Range metropolitan areas being less significant on a national scale. A map of the intramega freight network is shown in Figure 4.32. That main flow, between Denver and Albuquerque, encompasses over 80% of the Front Range's freight flows. There is minimal air freight between Denver and Colorado Springs. The small airports exchange air freight primarily with either Albuquerque or Denver. Due to the prominence of the main flow in the megaregion, Front Range's intramega freight network is considered a dyad.

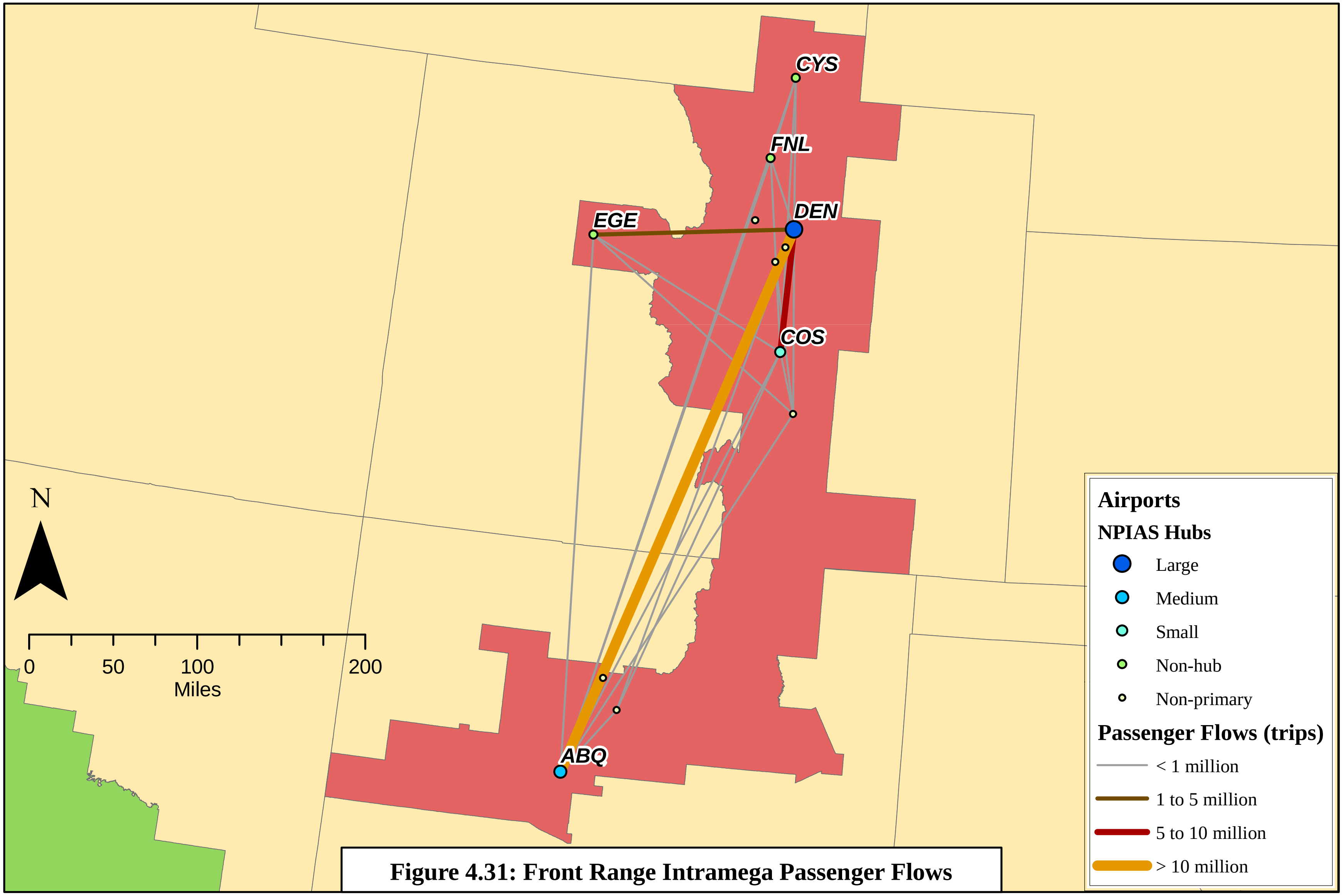

Figure 4.31: Front Range Intramega Passenger Flows

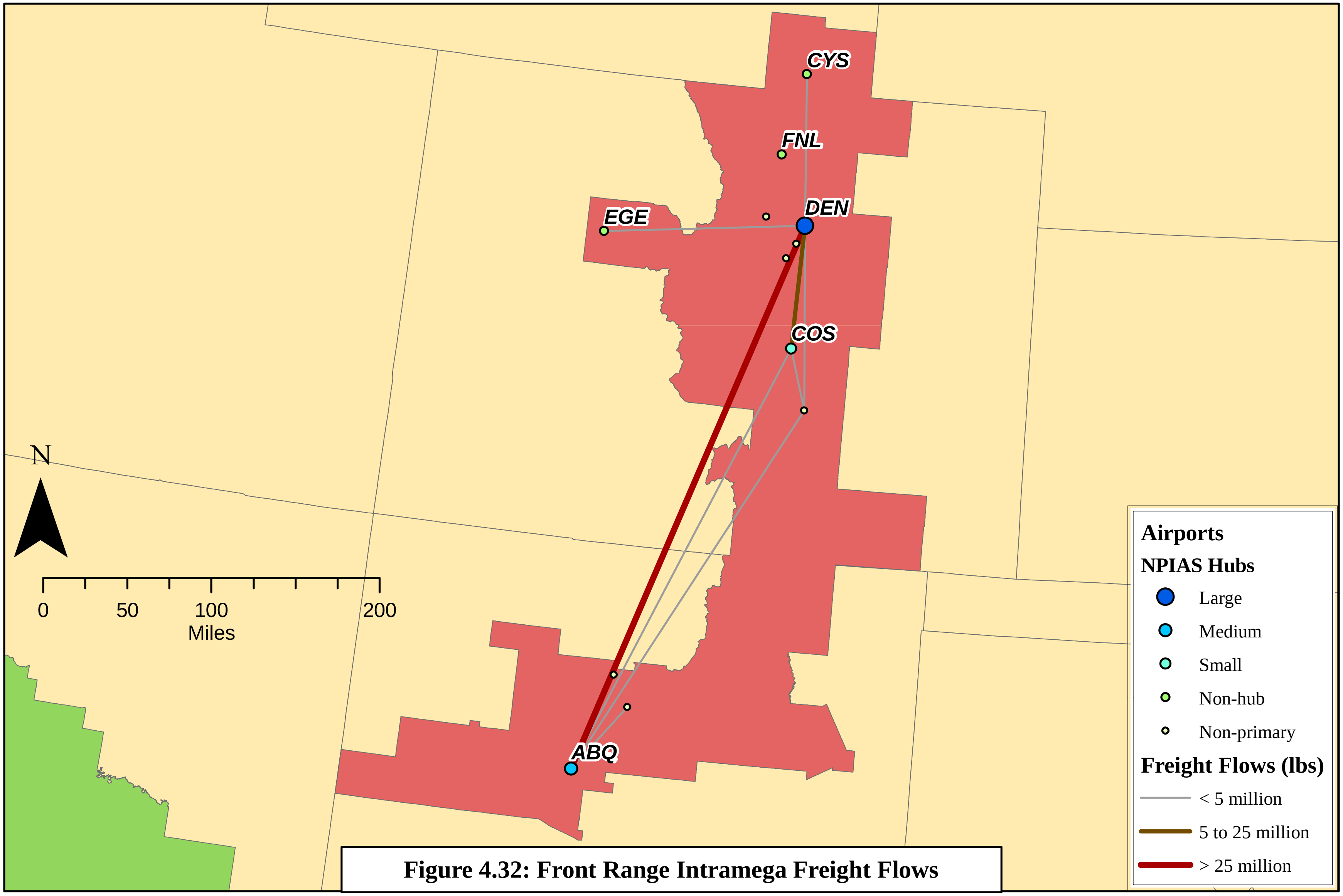

Figure 4.32: Front Range Intramega Freight Flows

4.5.4 Gulf Coast

4.5.4.1 Passenger Traffic

The Gulf Coast megaregions intramega passenger network has a strong focus on the Houston metropolitan area. HOU and IAH play similar roles in serving the megaregion to the south and to New Orleans, but IAH plays a greater role in connecting the megargion's eastern half. The greatest flows are between Houston and New Orleans, but no significant flows are paired with MSY, as seen in Figure 4.33. It is concluded that the Gulf Coast has a hub-focused intramega passenger flow network, with the hub being the Houston metropolitan area airports.

4.5.4.2 Freight Traffic

In the Gulf Coast megaregion's intramega freight network, IAH plays a larger role than HOU. MSY has a smaller role in the megaregion's freight network than it does in the passenger network. In Figure 4.34, it is seen that the megaregion's small and no-hub airports have relatively insignificant freight flows. It is clear by Houston's dominance in the Gulf Coast intramega network that it has a hub-focused system.

4.5.5 Midwest

4.5.5.1 Passenger Traffic

As the largest megaregion with a large number of airports, the Midwest passenger flow map, as seen in Figure 4.35, has a large density of intramega passenger movements. The network has a galactic shape, with airports in the center having greater flows than cities on the fringe. The Chicago metropolitan area has a large effect on this, as the distance between airports in Chicago and the fringe is far, encouraging significant air travel over

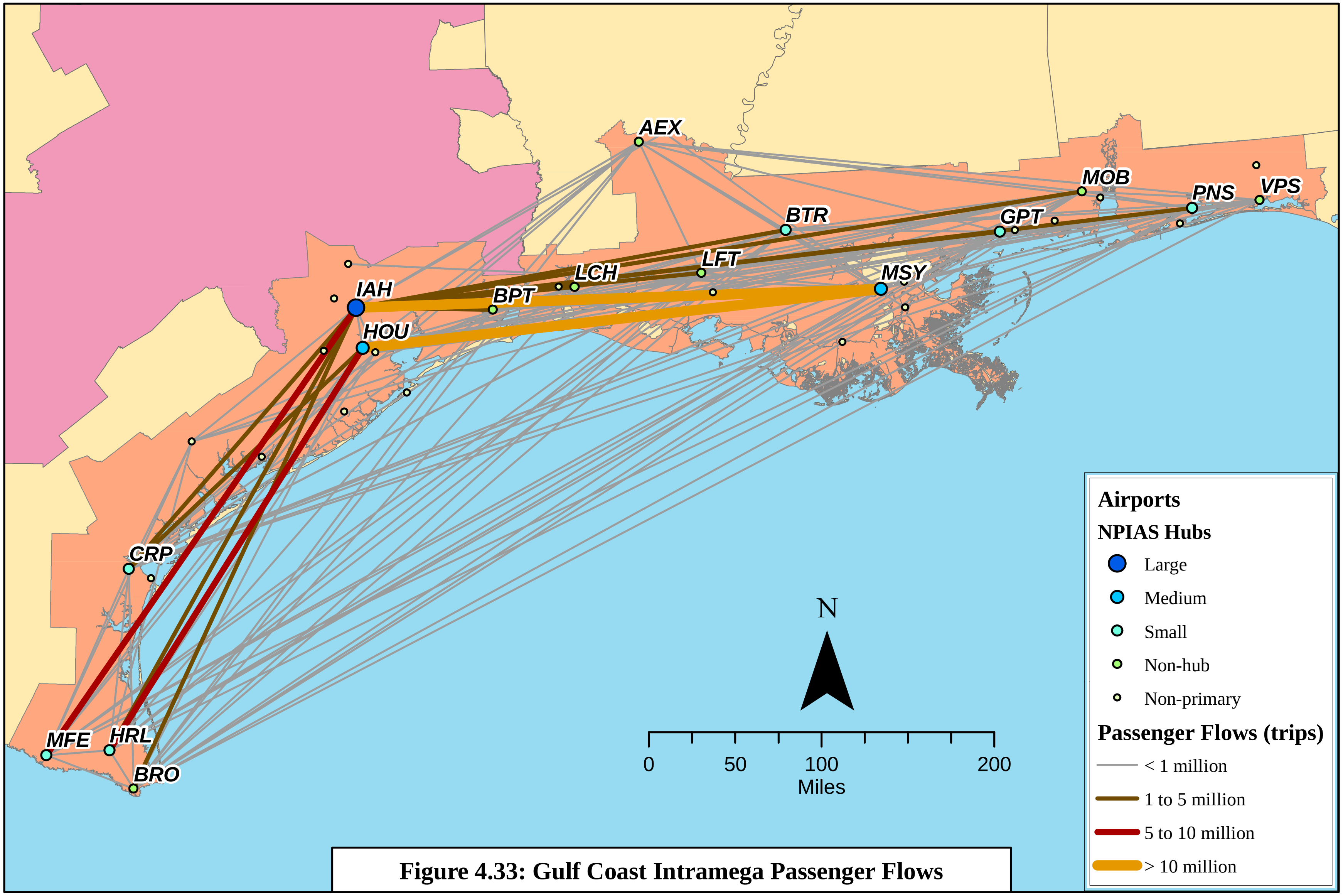

Figure 4.33: Gulf Coast Intramega Passenger Flows

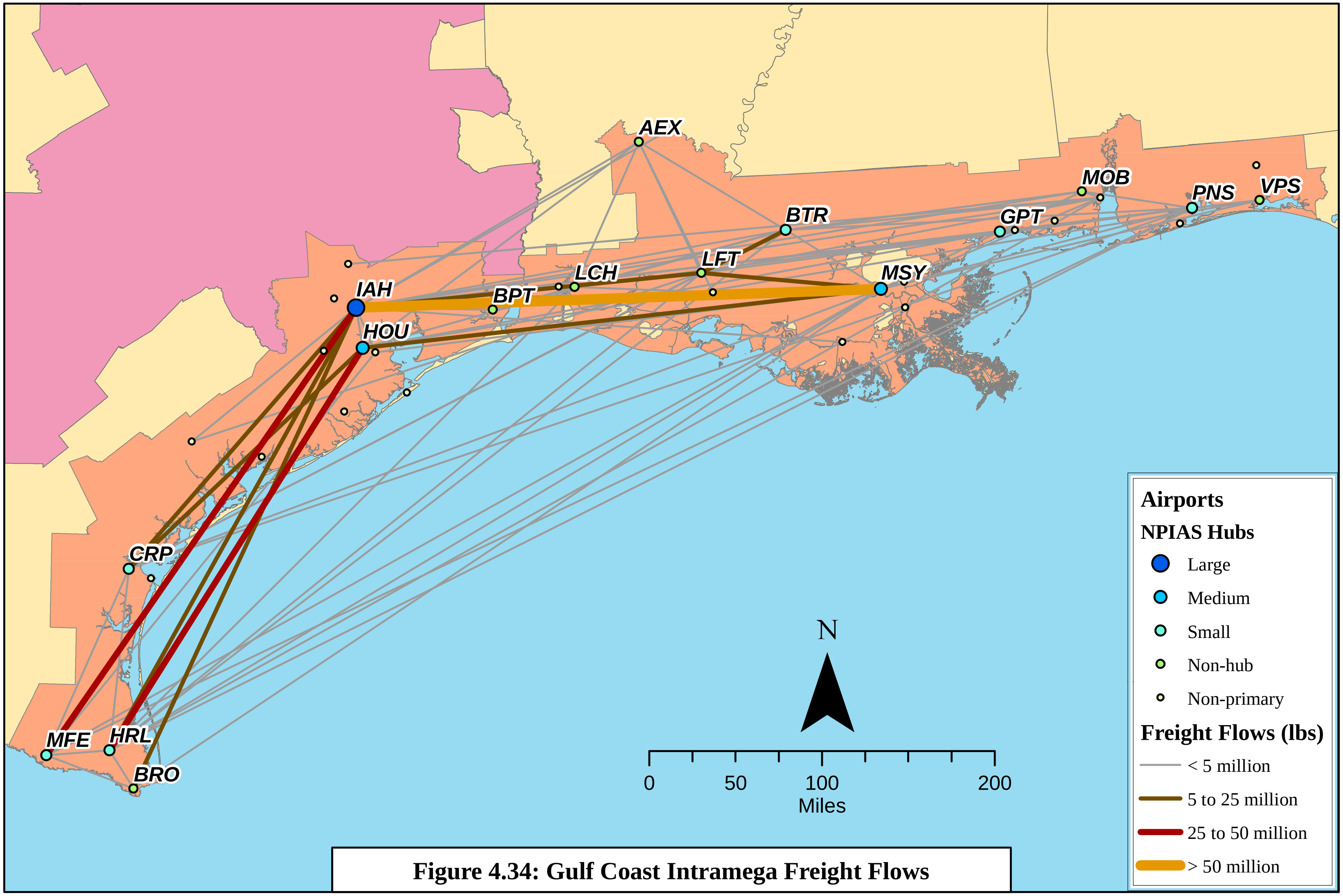

Figure 4.34: Gulf Coast Intramega Freight Flows

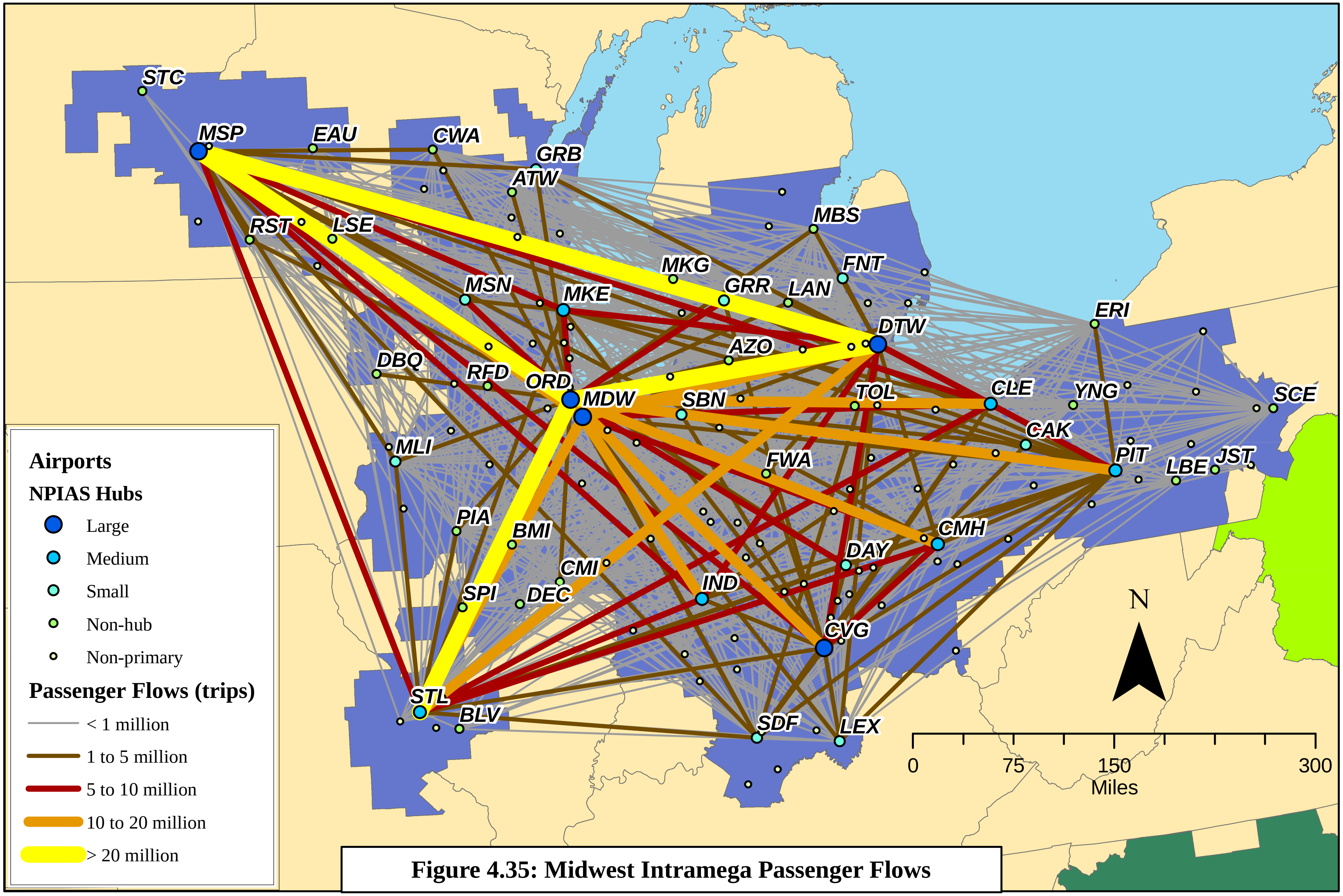

Figure 4.35: Midwest Intramega Passenger Flows

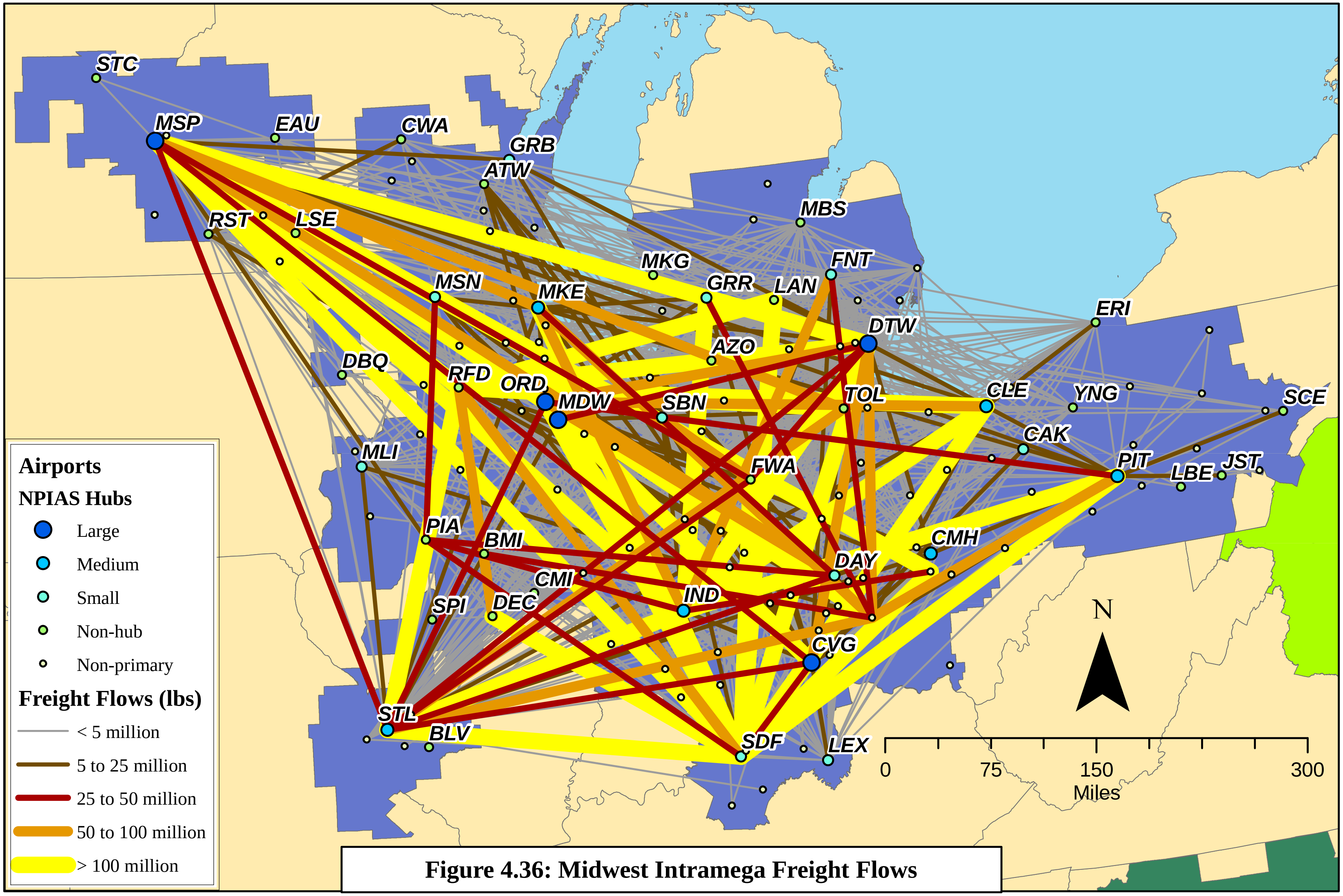

Figure 4.36: Midwest Intramega Freight Flows

other modes. The Chicago airports are not the only large role players, as there are strong air travel patterns even amongst the fringe cities of the Midwest, such as St. Louis, Minneapolis, Pittsburgh, Detroit, and Cincinnati. There is a slight reduction in intramega air travel as you head farther from Chicago to the east. Flows with cities in Ohio and to the east have weaker connections with each other and with cities in the west; it appears intramega traffic is not as prolific on the eastern end of the megaregion, farther from Chicago.

The metropolitan areas with the greatest intramega passenger flows in the Midwest are Chicago, Minneapolis, St. Louis, and Detroit. The next tier of cities with intramega flows are Cleveland, Indianapolis, Pittsburgh, Colombus, and Cincinnati. In the Chicago area, ORD handles a greater share of intramega passenger flow, with Midway close behind. The Chicago dominance in intramega traffic reduces Milwaukee, a prominent medium hub within the region, to handling very little intramega traffic, as compared to other medium hubs in the megaregion. St. Louis, another medium size hub, handles a great portion of intramega traffic, with strong flows to Chicago airports and Detroit. Cincinnati is the weakest of the Midwest's large hubs, with its most significant flows to Chicago and Colombus.

4.5.5.2 Freight Traffic

The Midwest freight network is the densest of all megaregions. Prominent flows occur between nearly all major large and medium hubs, as seen in Figure 4.36. What is most noticeable is the effect of SDF, the location of UPS's freight hub, and the prominent flows it shares with every major airport in the Midwest. Compared to nearby LEX, another small hub, one can see the difference a freight hub makes. Minneapolis, Indianapolis, and the Chicago airports (including RFD) are also the endpoints of a large number of prominent pairs. The flows have a galactic shape, with major concentrations focused on ORD, MDW, and SDF.

The freight network of the Midwest also consists of several prominent small and non-hubs airports that play much stronger roles in freight than they do passenger traffic. Airports such as TOL, LCK, LAN, GRR, RFD, and FWA all have prominent connections to either RFD, SDF, or MSP. The Midwest uses non-passenger hub airports quite often to move freight traffic.

4.5.6 Northeast

4.5.6.1 Passenger Traffic

The Northeast has one of the strongest intramega flow networks, fueled by eight large hub airports, the most in the nation. The flows are centered on the four largest metropolitan areas of the megaregion: Boston, New York, Philadelphia, and Washington D.C, as seen in Figure 4.37. The only two flows that are above 20 million passenger trips travel through LGA, to BOS in the north and DCA in the south. The larger, more internationally focused airports in New York, EWR and JFK do not play as large of a role in connecting the major metropolitan areas. JFK especially has not one flow even half as large as LGA, and EWR is connected strongly to BOS, as much so to any Washington airport. IAD and BWI both have significant flows to BOS, but less significant to the other large hub airports (although BWI has some significant flows to medium and small hub airports in New England). PHL plays a relatively small role in intramega traffic, with a large flow to BOS and less significant flows to New England interior airports.

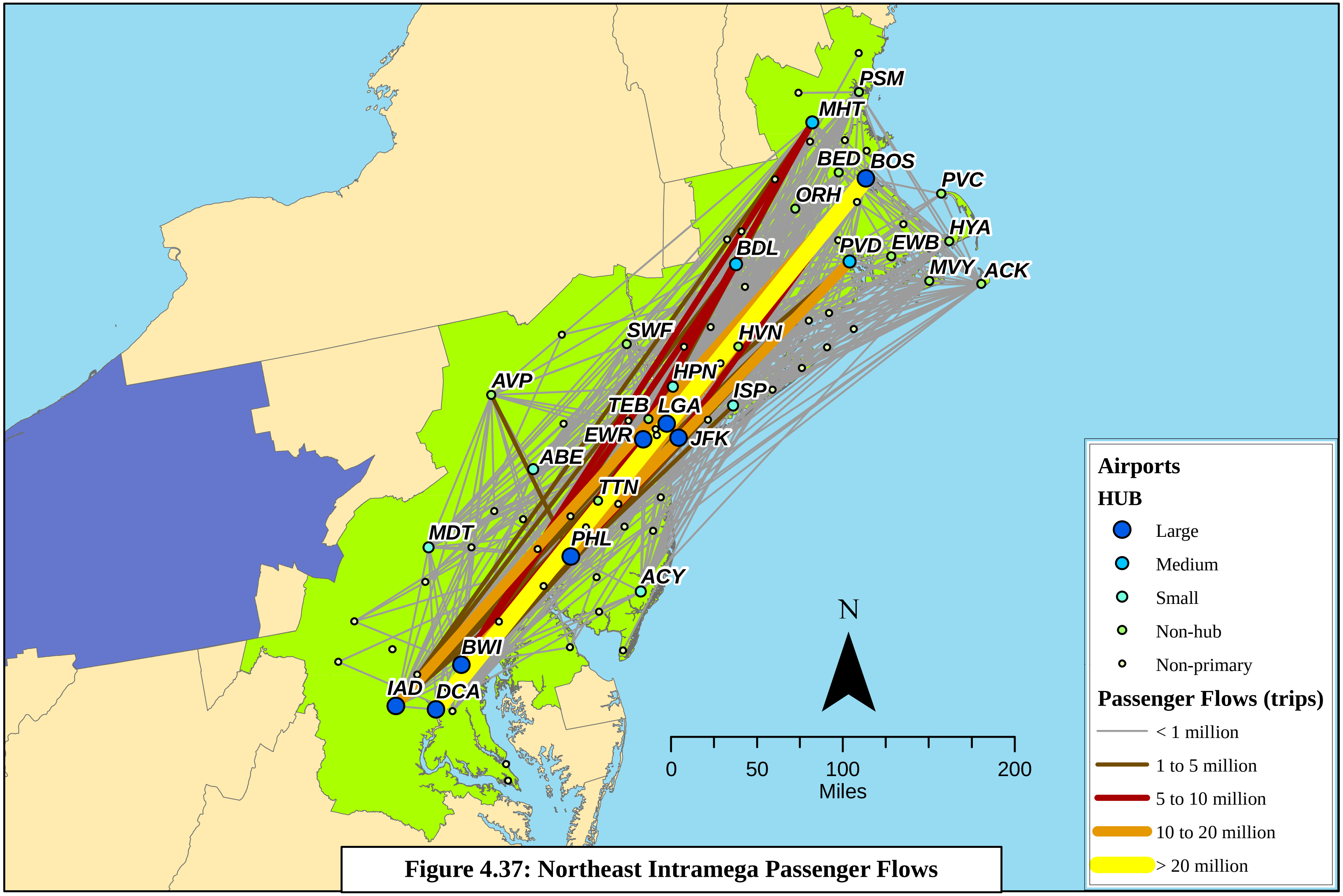

Figure 4.37: Northeast Intramega Passenger Flows

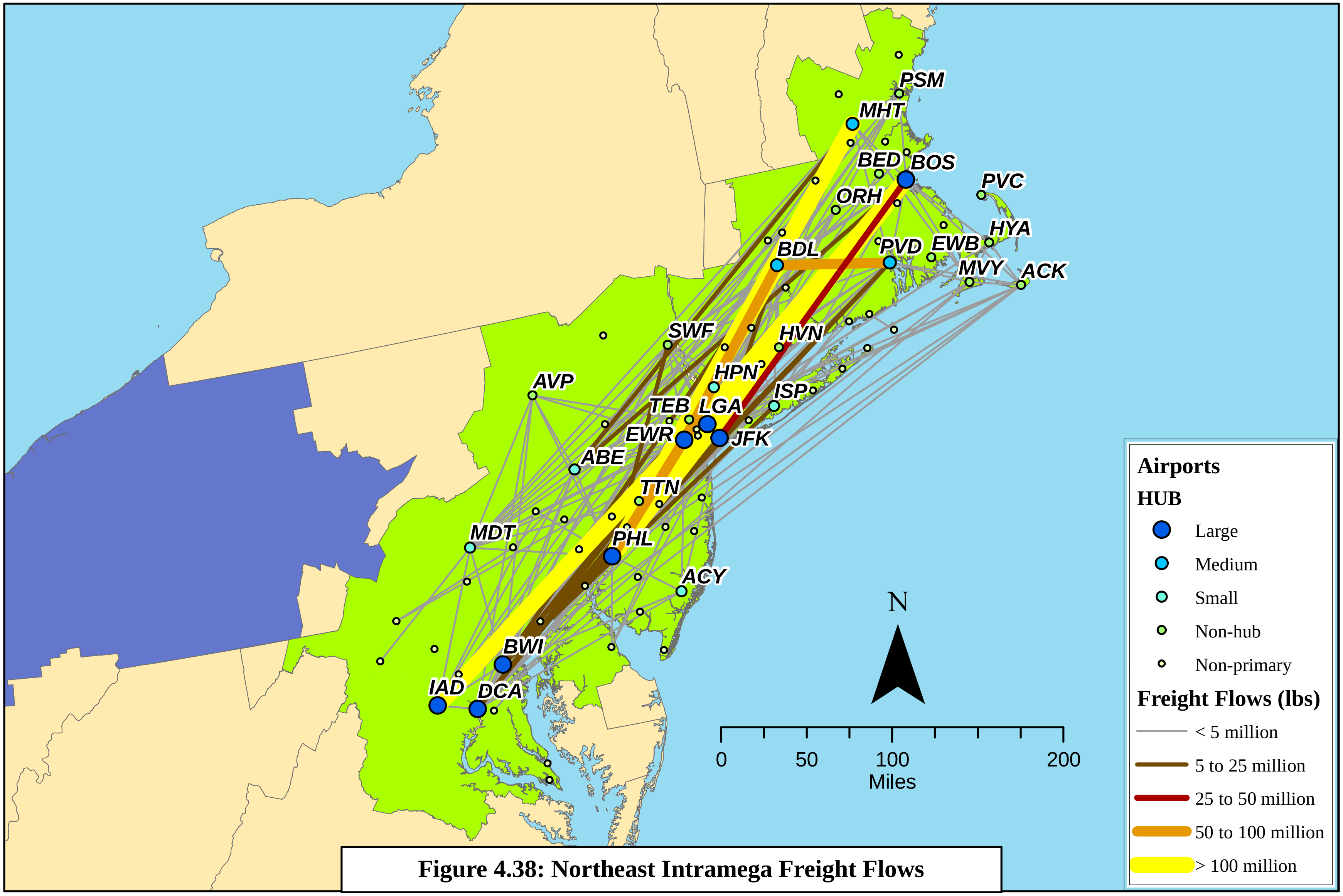

Figure 4.38: Northeast Intramega Freight Flows

The Northeast megaregion's flows are not galactic in that there is still a strong focus on the major airports in the main cities. Its shape is best characterized as a tri-pole network, with a focus on New York, Washington, and Boston.

4.5.6.2 Freight Traffic

The Northeast megaregion's freight network's largest flows are paired between a variety of airports, with very few other prominent flows. The largest flows occur between PHL and MHT, PHL and BDL, PHL and BOS, EWR and BOS, and EWR and IAD. Other prominent flows go through BDL as well, largely an effect of it being a hub for UPS. The remaining large hub airports, as seen in Figure 4.38, play minor roles in the movement of air freight in the Northeast megaregion, although the majority of flows of 5 to 10 million pounds of freight move through the four major metropolitan areas. Due to the wide range of airports that encompass the Northeast megaregion's intramega freight flows, with major foci at PHL, EWR, and BDL, it fits the description of a galactic network.

4.5.7 Northern California

4.5.7.1 Passenger Traffic

Northern California has one of the smallest intramega passenger flows, and a map of its intramega flows reveals no passenger flows greater than 5 million trips as in other maps. The connections in Northern California primarily involve the Reno metropolitan area to the Bay Area metropolitan area, as seen in Figure 4.39, to OAK, SFO, and SJC. The remaining significant passenger flows are from SFO only, to MRY, FAT, and SMF. It is clear that the collective Bay Area airports are the focal point of the Northern California megaregion's intramega flows, and thus it is considered a hub-centered network.

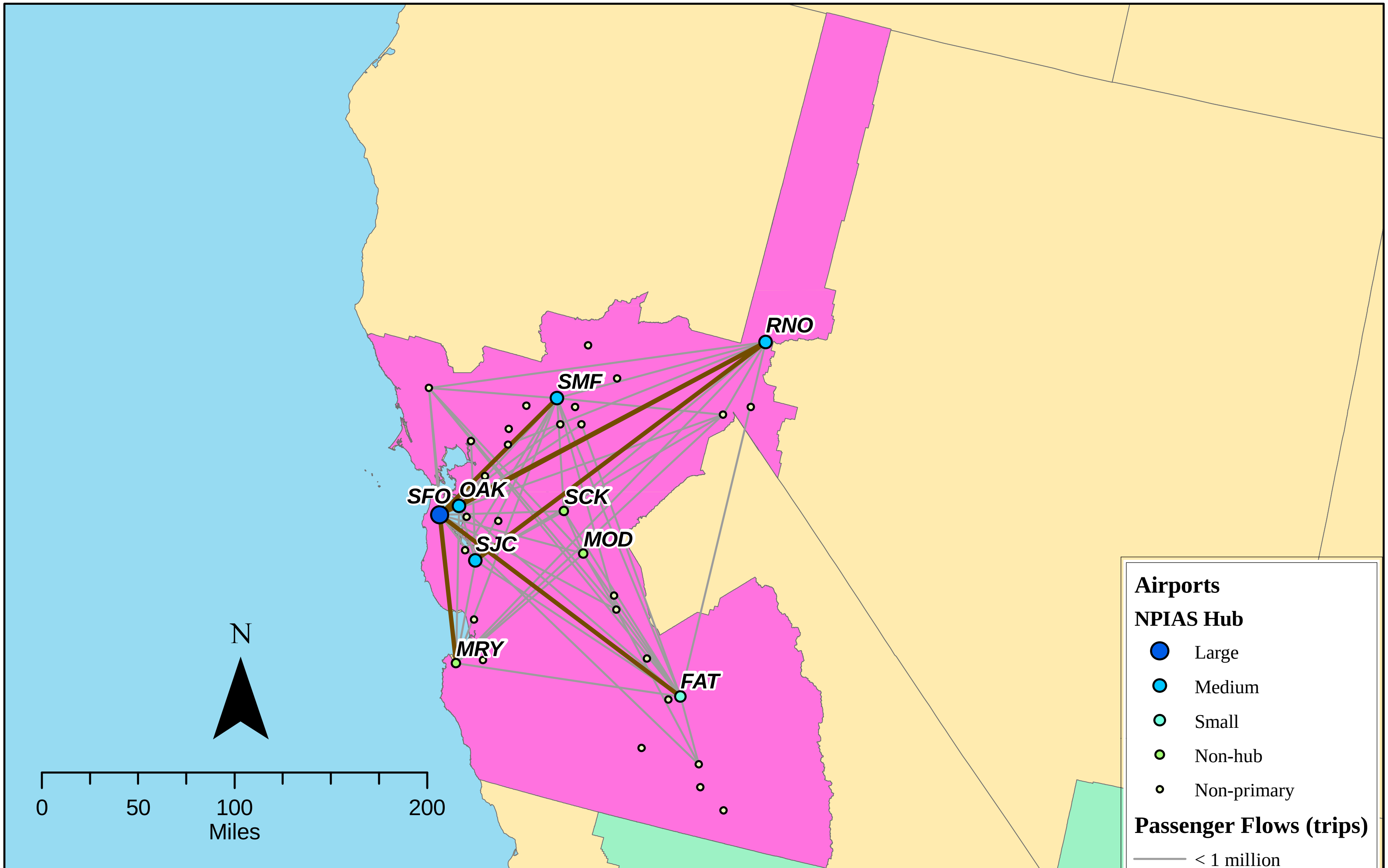

Figure 4.39: Northern California Intramega Passenger Flows

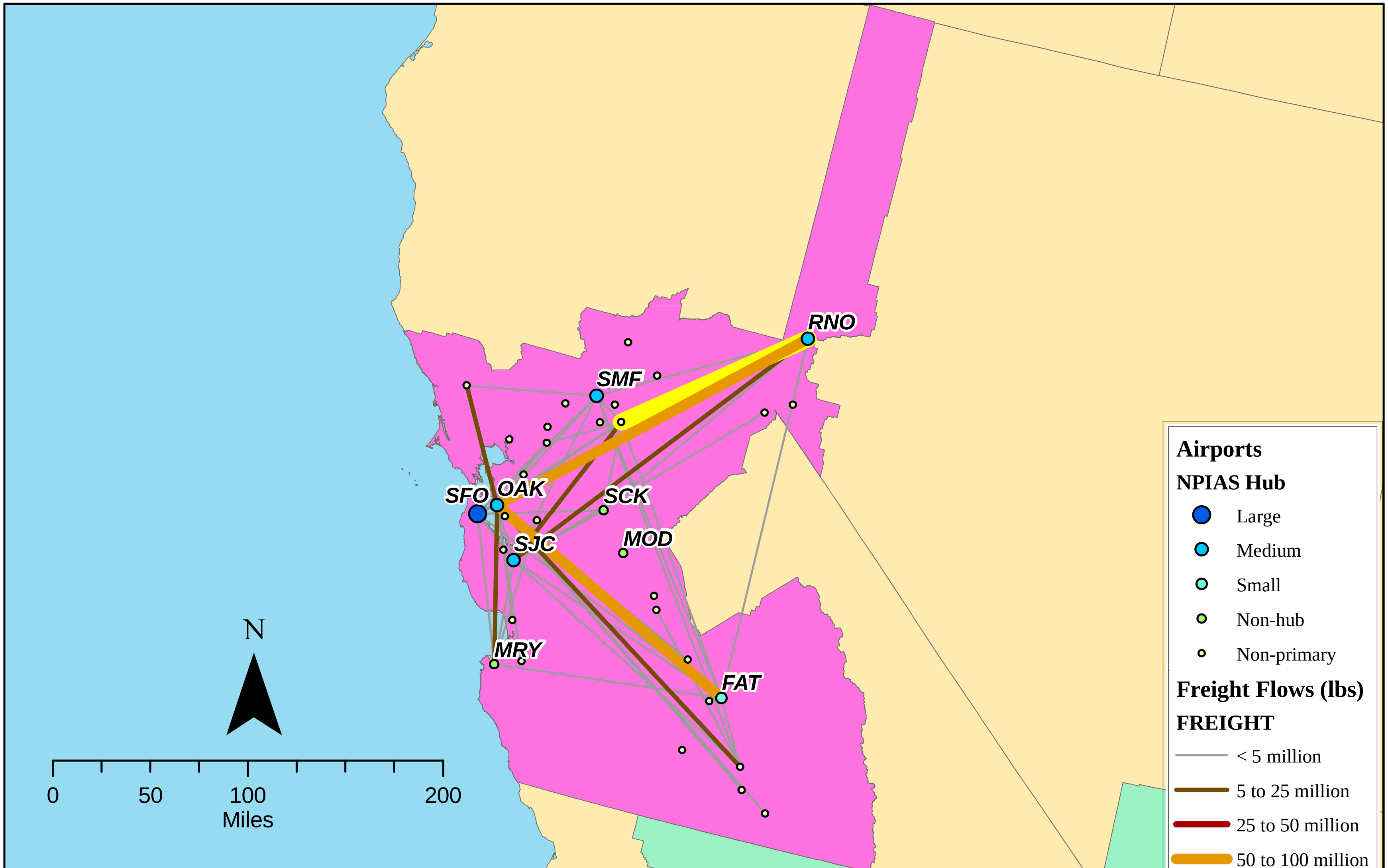

Figure 4.40: Northern California Intramega Freight Flows

4.5.7.2 Freight Traffic

The largest flow in the Northern California intramega freight network is from RNO to MHR, Sacramento's cargo airport. The only other airport which is significantly connected to MHR is SJC. Otherwise, OAK is the hub of the Northern California intramega air freight system, as seen in Figure 4.40, similar to SFO for passenger traffic. There are strong freight flows from OAK to RNO and FAT. Despite the large flow between Reno and Sacramento, the majority of the Northern California megaregion is a hub-centered network focused on the Bay Area metropolitan area.

4.5.8 Piedmont

4.5.8.1 Passenger Traffic

The Piedmont megaregion boasts two major airline hubs in Charlotte and Atlanta, as well as several metropolitan areas across four states. The megaregion's standardized intramega network flows are fairly high compared to other megaregions. A map of the megaregion and its passenger flows is shown in Figure 4.41. Although there are significant flows from ATL to each of the major metropolitan areas, each of the North Carolina metropolitan areas have significant flows to CLT. However, the flows from these same metropolitan areas have stronger flows to ATL. Many non-hub airports have minor flows to each of CLT and ATL. Due to the prominence of ATL and CLT in intramega traffic, and all smaller airports are focused on the two, the Piedmont in terms of intramega passenger traffic is a dyad.

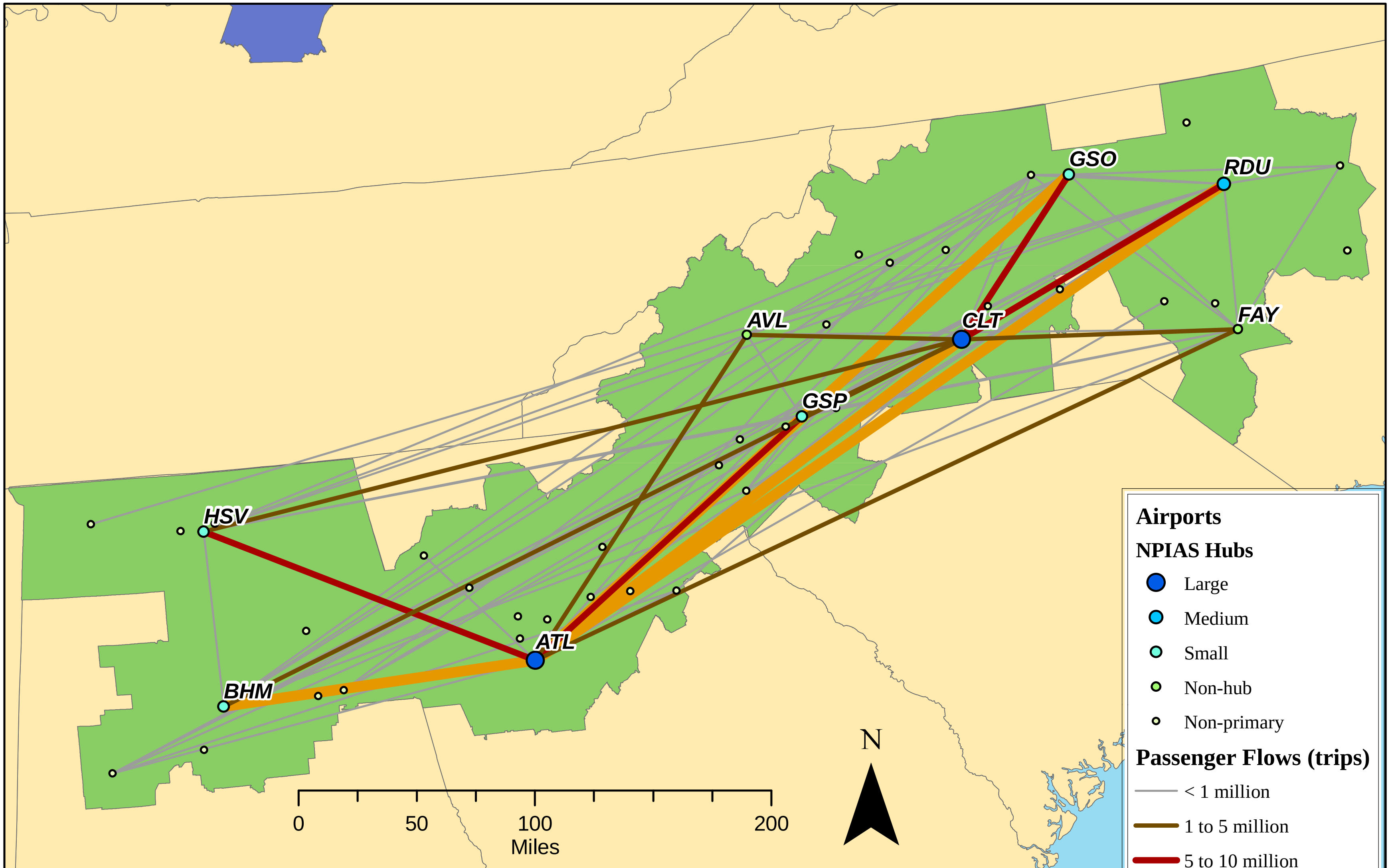

Figure 4.41: Piedmont Intramega Passenger Flows

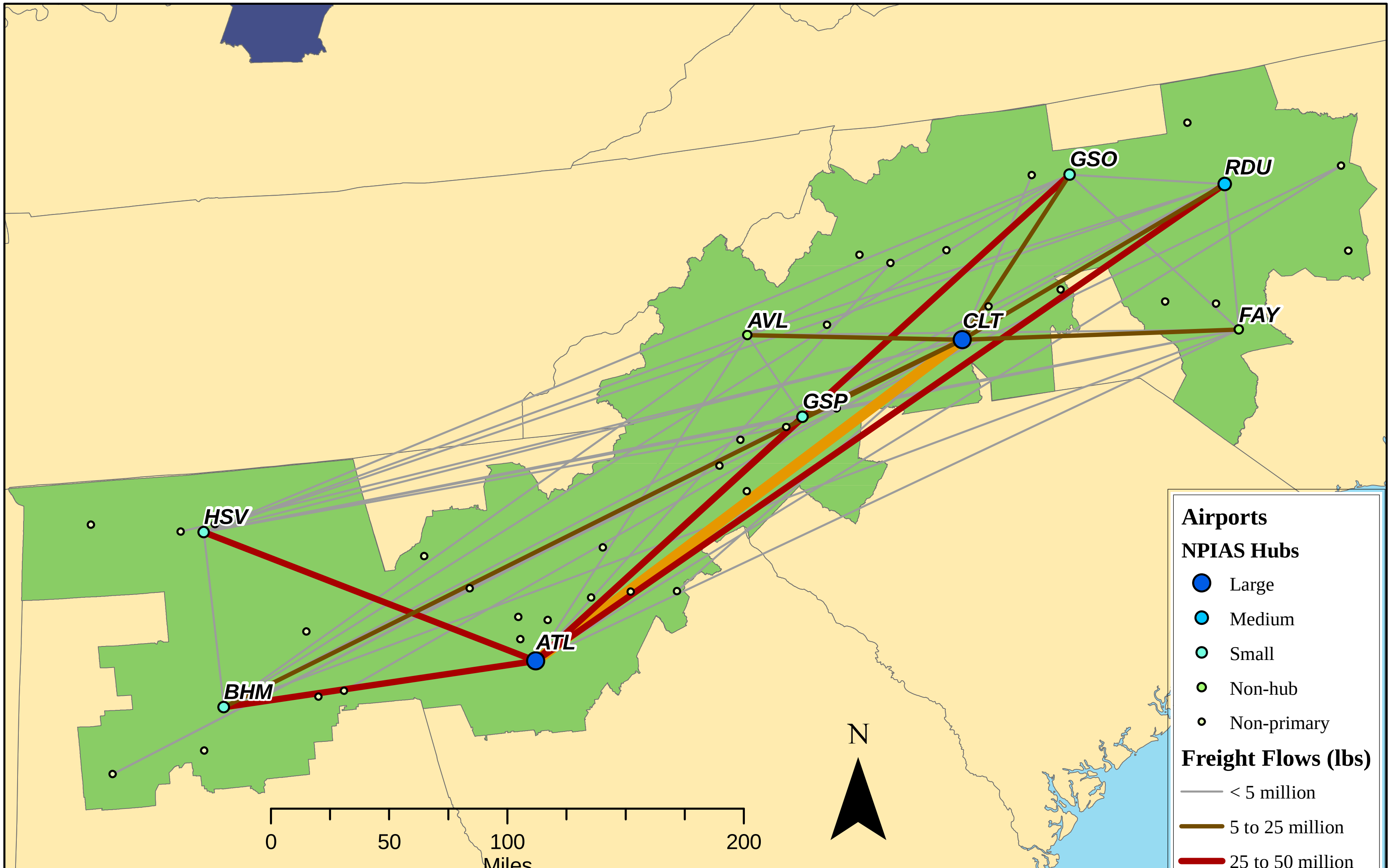

Figure 4.42: Piedmont Intramega Freight Flows

4.5.8.2 Freight Traffic

The Piedmont megaregion's freight network is dominated by ATL. Although there is a strong flow between ATL and CLT, the remaining metropolitan area airports, including GSO, RDU, GSP, HSV, and BHM have more prominent flows to ATL, with smaller yet significant flows to CLT. The only primary airport in the Piedmont megaregion not to have a freight flow greater than 5 million pounds of freight to ATL is AVL. The intramega freight system of the Piedmont megaregion, as seen in Figure 4.42, is best described as a hub network.

4.5.9 Southern California

4.5.9.1 Passenger Traffic

The intramega passenger flow network in Southern California has a large flow between the Los Angeles and Las Vegas metropolitan areas. The five main airports of the Los Angeles area (LAX, BUR, ONT, SNA, and LGB) all have significant flows to LAS. In addition though, each of LAX and LAS have strong connections with the San Diego metropolitan area, as seen in Figure 4.43. The triangular connection between these three large hub airports make up three of the top five intramega flows (ONT and BUR's connection to LAS is larger than that from LAX to SAN). The small hub and non-hub airports have their only significant flows to the three main airports, and non-hub and non-primary airports connect to each other with small flows. Overall, Southern California's intramega flows have a tri-pole shape that dominates the rest of the flow network.

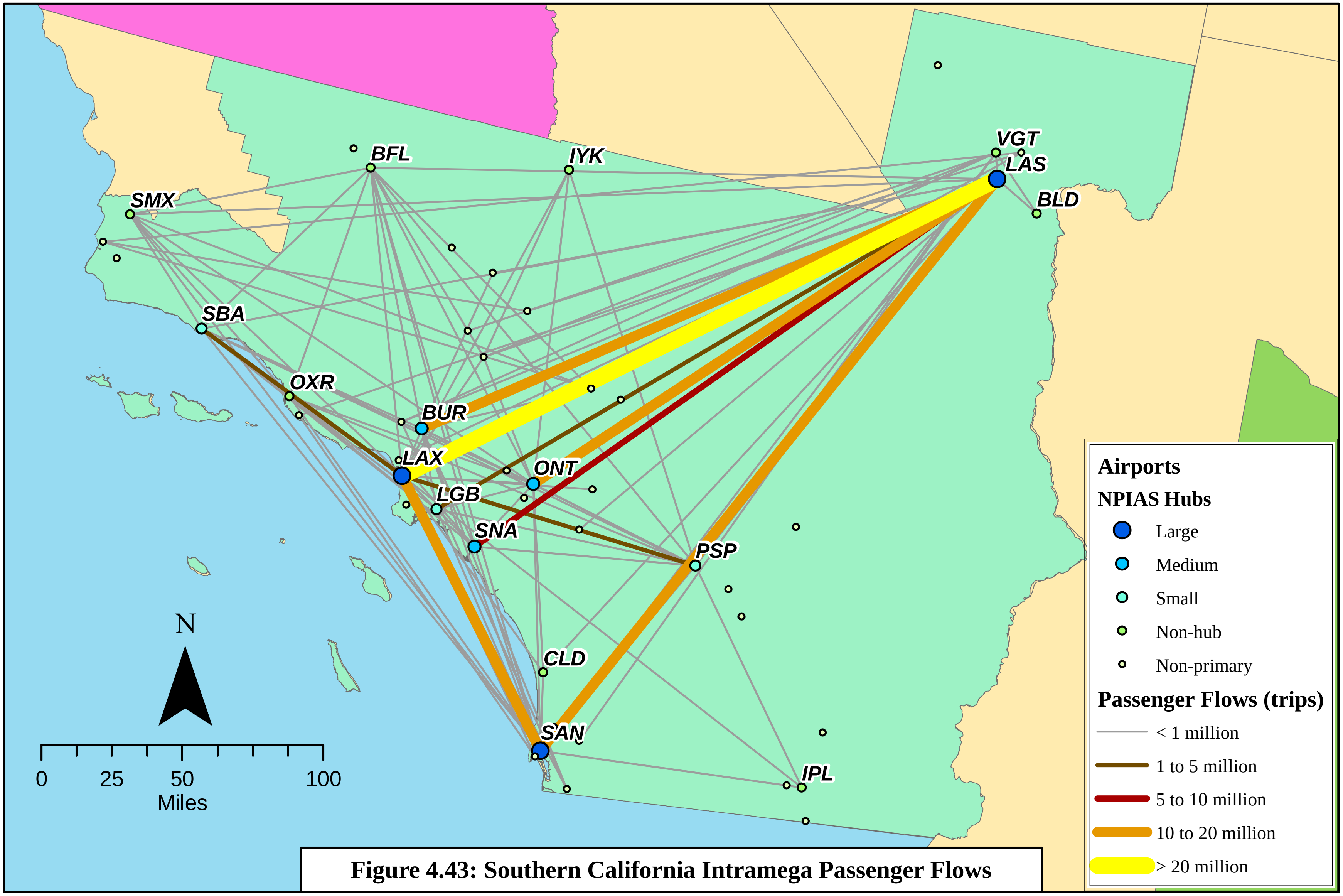

Figure 4.43: Southern California Intramega Passenger Flows

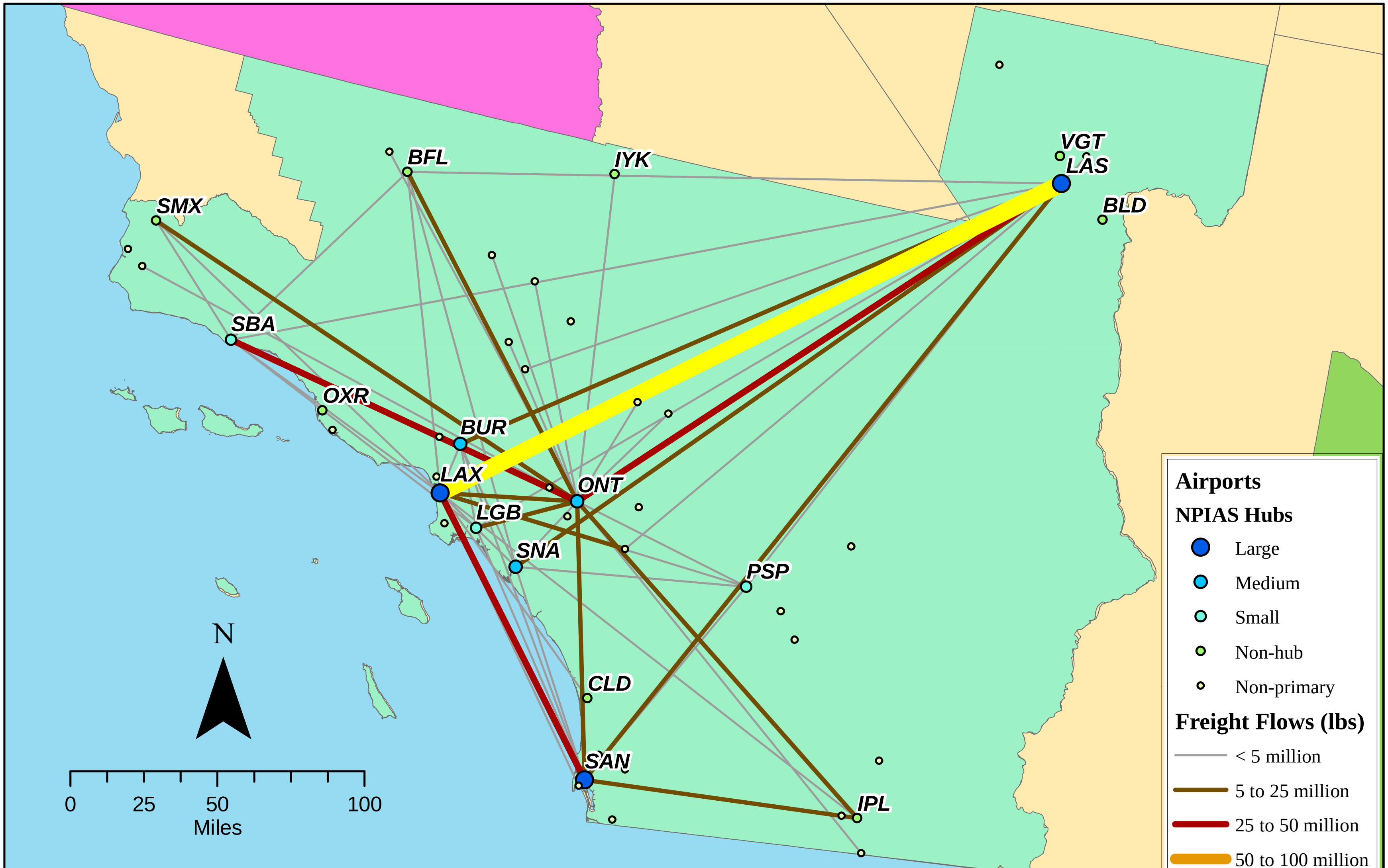

Figure 4.44: Southern California Intramega Freight Flows

4.5.9.2 Freight Traffic

Two features stand out in the map of Southern California's intramega freight network, seen in Figure 4.44,. First, the main flow in the network is between LAX and LAS, dominating all other flows. Second, is the prominence of ONT within the freight network. Due to the location of a UPS hub at ONT, more cities have significant flows to ONT than to any of the three large hub airports of LAX, LAS, and SAN. In addition, other Los Angeles metropolitan area airports, such as BUR and SNA have significant flows to LAS. Outside the large and medium hub airports, there is not always a predictable strongest connection. IPL, for example, connects primarily to SAN and ONT. Due to the combination of ONT's hub status, the large flow between LAX and LAS, and smaller airports not having significant connections to each metropolitan area, the Southern California intramega freight network is galactic.

4.5.10 Southern Florida

4.5.10.1 Passenger Traffic

Passenger traffic in the Southern Florida megaregion occurs between each of the two metropolitan areas on the Interstate 4 corridor, Tampa and Orlando, and each of those on the southern Atlantic Coast, Fort Lauderdale and Miami. A map of the megaregion's passenger flows is shown in. The largest flow is between MIA and MCO, as seen in Figure 4.45, the greatest distance among the four airports. The Jacksonville metropolitan area does not have as strong of a connection with the southern part of the megaregion, as neither of the flows from the four main southern airports have a flow with JAX greater than 5 million trips. Southern Florida's small and non-hub airports are scattered around

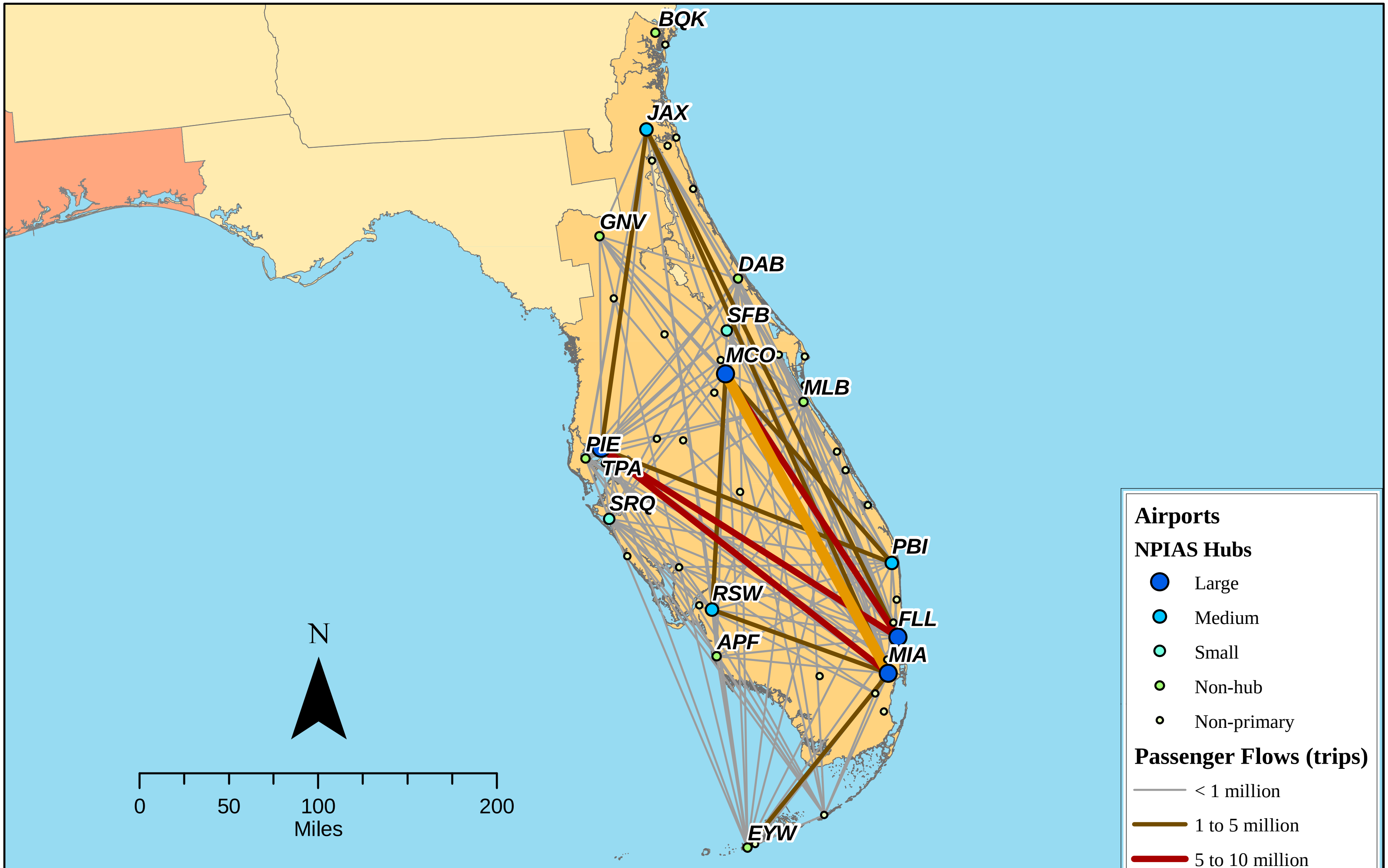

Figure 4.45: Southern Florida Intramega Passenger Flows

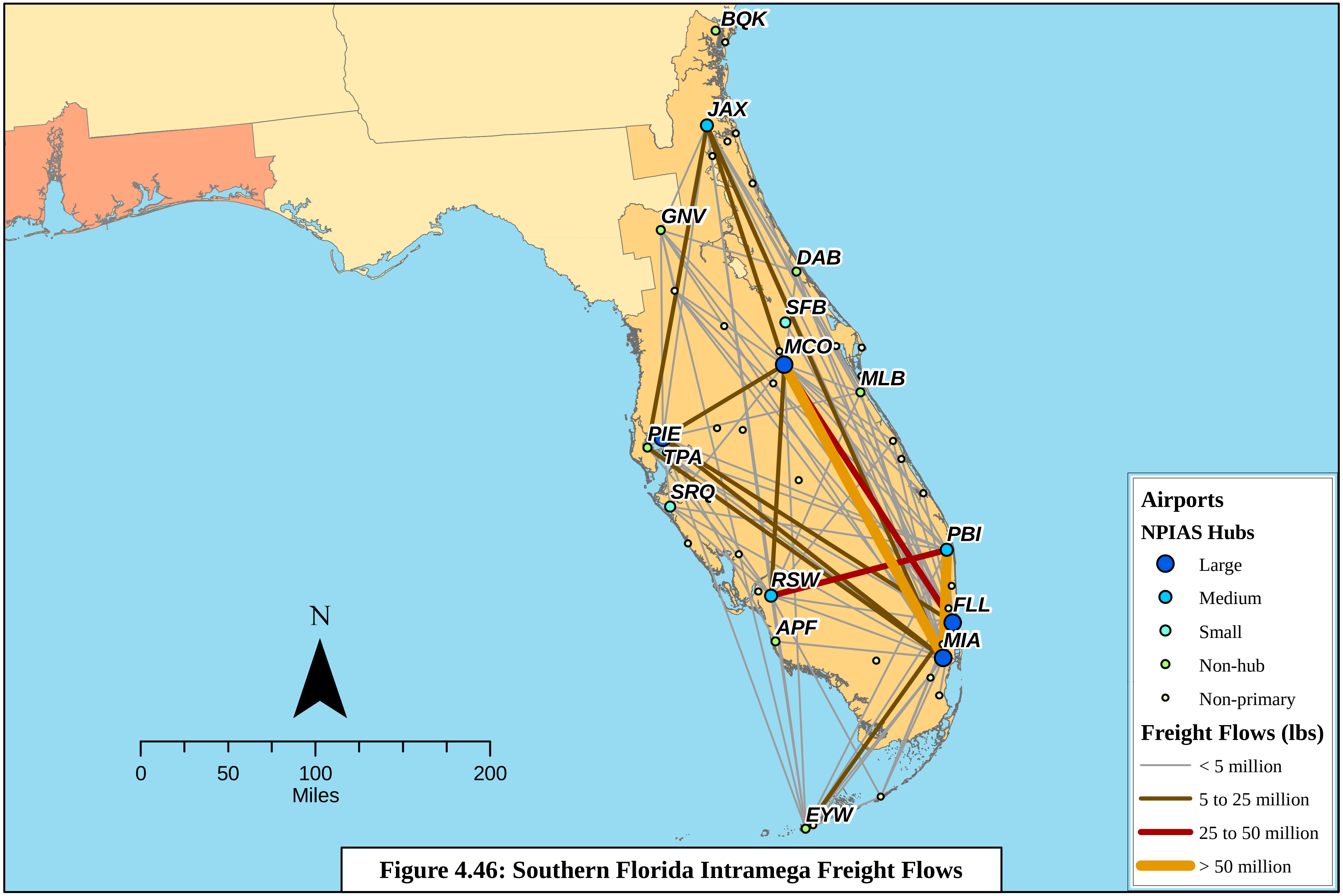

Figure 4.46: Southern Florida Intramega Freight Flows

the rim of the megaregion, and have a connection with all of the medium and large hub airports. Southern Florida's intramega passenger flow network is essentially a dyad system.

4.5.10.2 Freight Traffic

MIA is the focal point of the Southern Florida freight network, with flows greater than 25 million pounds of freight occurring even to FLL just up the coast. From MIA there are two pairs over 50 million pounds of freight to MCO and PBI. Away from MIA, flows are less significant, but still are between the megaregion's medium and large hub airports, as seen in Figure 4.46. Southern Florida's intramega freight network is hub-focused, revolving around MIA.

4.5.11 Texas Triangle

4.5.11.1 Passenger Traffic

The Texas Triangle lives up to its name in shape in terms of its passenger flows, as seen in Figure 4.47. With the corners at the Dallas-Forth Worth metropolitan area, Houston metropolitan area, and San Antonio and Austin, the triangular air pathways are heavily trafficked. The top connection in the megaregion is between HOU and DAL, indicating that the megaregion's major international airports at DFW and IAH are not as significant in intramega traffic. The significance of the flows between the cities indicates that the Dallas-Forth Worth metropolitan area is the greater focal point of the megaregion, as all flows greater than 20 million passenger trips are out of DFW or DAL, with lesser flows headed between San Antonio and Austin to Houston. Despite Dallas's prominence, the

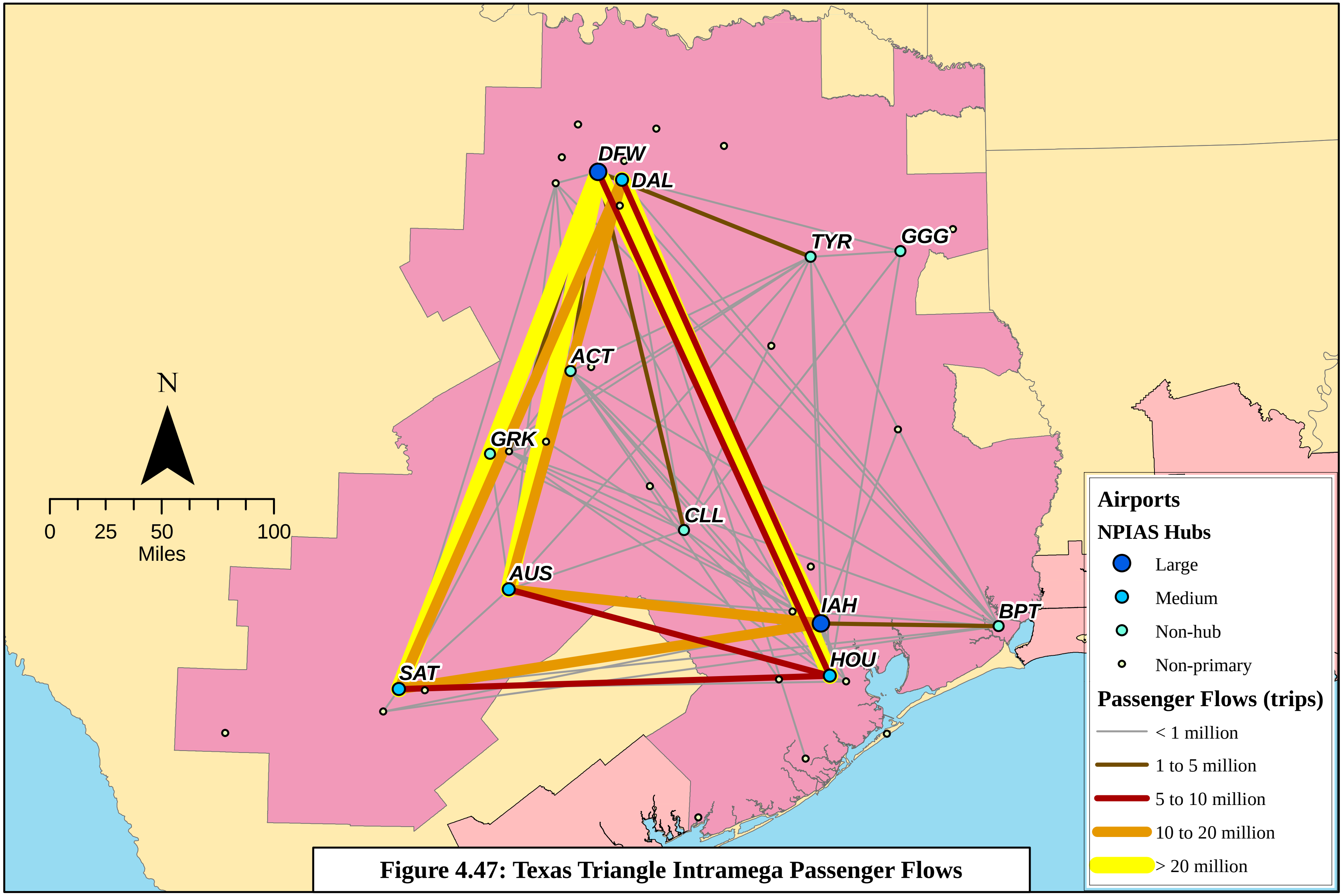

Figure 4.47: Texas Triangle Intramega Passenger Flows

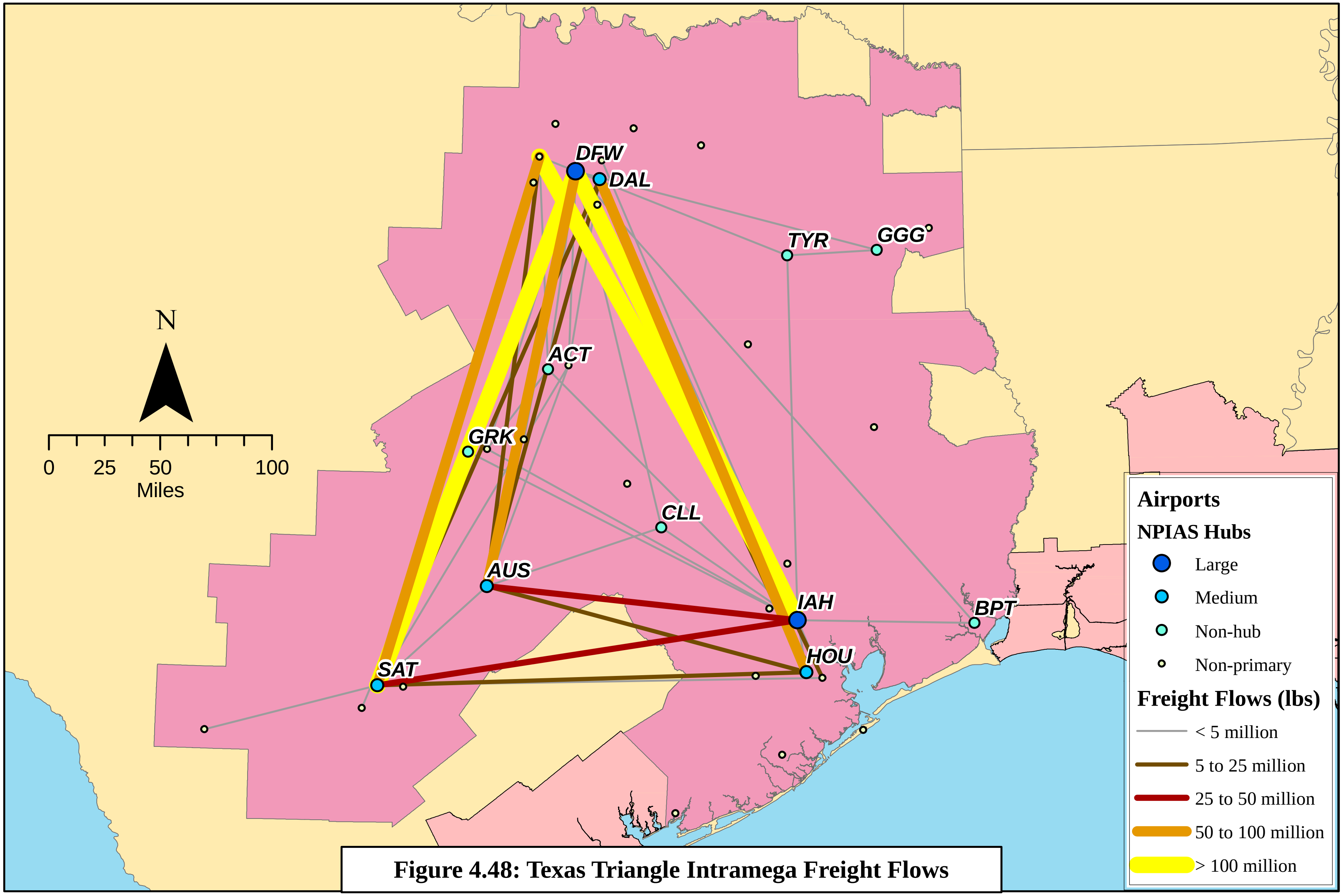

Figure 4.48: Texas Triangle Intramega Freight Flows

Texas Triangle cannot be considered a hub-focused network, and the tri-pole shape is a better description.

4.5.11.2 Freight Traffic

The triangular shape of the cities in the Texas Triangle is still visible in the megaregion's freight flows, but the link between Houston, San Antonio, and Austin is much weaker compared to those to Dallas-Fort Worth. The map of the freight flows in Figure 4.48 shows major flows to DFW, DAL, and AFW. For freight traffic, DFW and IAH are dominant over DAL and HOU, respectively. Within the Dallas-Forth Worth area, though, AFW shows up as a focal airport for freight, due to the location of a FedEx hub at the airport. Unlike the passenger network, the freight network of the Texas Triangle is best described as hub-based, referring to the dominance of the Dallas-Forth Worth area airports.

4.5.12 Summary

Every megaregion's intramega flows are indicative of the connections between its population and business centers. There is no single type of flow network that can characterize a megaregion's intramega flows. Even between a megaregion's passenger and freight movements there can be differences in the network's spatial form, due to some airports having higher propensities for different types of flows. Four types of spatial forms were identified in this section, and each megaregion's passenger and freight flows were classified into one of the categories. The four types are discussed below with examples.

The first, and simplest, type of network is a hub-focused system. Networks within this classification are characterized by a system of flows that revolve around a single airport or several airports within a metropolitan area. There are generally limited connections occurring away from the center hub airport, such that the majority of market pairs exist with the hub airport. Among passenger systems, the Gulf Coast (hub at Houston), Front Range (DEN), and Northern California (Bay Area) megaregions are hub-focused. Among freight systems, the Gulf Coast (hub at Houston), Northern California (Bay Area), Piedmont (ATL), Southern Florida (MIA), and Texas Triangle (hub at Dallas-Fort Worth) are hub-focused.

The second type of spatial system classification is a dyad. These megaregions' intramega flow networks revolve around two metropolitan areas, with the majority of flows occurring between the two. In addition, most flows in the megaregion go to and from the two poles of the megaregion, and much less often between each other. Among passenger systems, the Arizona Sun Corridor (PHX and TUS), Cascadia (SEA and PDX), Piedmont (ATL and CLT), and Southern Florida (Atlantic Coast and I-4 regions) have dyad networks. Among freight systems, the Arizona Sun Corridor, Cascadia (Seattle and PDX), and the Front Range (DEN and ABQ) have dyad networks.

The third type of spatial form is a tri-pole network. These systems are focused on three primary airports or metropolitan areas, with less significant networks outside. As these tend to be larger megaregions with more complex networks, it is more likely in these forms to see flows occurring between those airports not at the poles, however there is always an orientation towards the three foci. Passenger systems that can be described as tri-poles are the Northeast (Washington, New York, and BOS), Southern California

(Los Angeles, LAS, and SAN), and of course the Texas Triangle (Dallas, San Antonio/Austin, and Houston). No freight networks were classifiable as tri-poles.

Galactic networks are the most complex megaregion system form. In this type of spatial shape, many cities and airports have significant flows between them. They may be a variety of hubs that exist, significant flows happening between many airports with no dominating pattern, and smaller airports that do not always have significant flows to all major airports, but have significant flows with each other. The galactic network shows a smaller focus on certain airports, and starts to lean towards a point-to-point system. Only one passenger system has a galactic spatial form, the Midwest. Three freight systems have galactic forms: the Midwest, Northeast, and Southern California.

Six megaregions do not have the same spatial form for both their passenger and freight networks. This is indicative of airports or cities within the network that may have a strong passenger or freight focus, but not both. For example, ONT is a minor player in Southern California's passenger system, but affects its freight system heavily as a hub for UPS. This shifts the freight system into galactic form, while its passenger system is a tri-pole. In the Piedmont, Charlotte is a major player in the passenger system due to a US Airways hub, but its freight role is minimal compared to ATL. This causes the Piedmont to have a dyad passenger system, and a hub-focused freight system. The other four megaregions with differences are: the Front Range, Southern Florida, Northeast, and Texas Triangle.

The results indicate that there is not a strong relationship between the classification of a megaregion's passenger spatial flow network and the connectivity of its intramega standardized passenger flows. Thus, a megaregion that has a hub-focused passenger network is only slightly less likely to have a population less active in travel than a tri-pole or galactic network. This relationship is not extremely indicative, because there are glaring exceptions to any generalization. The Gulf Coast, for example, has high standardized flows and is a hub-focused network, while the Northeast has a tri-pole network yet is in the middle of all the megaregions ranked by standardized flows. Still, with four of the top six of standardized flows (by population and by economic productivity) being galactic or tri-pole passenger networks, and the bottom five being a dyad or hub-focused, there could be a slight relationship. Flows standardized by area do indicate, however, a relationship by spatial network type. Galactic and tri-pole networks are more active in air travel per size of the megaregion than a dyad or hub-focused networks.

Freight travel does not have an identifiable relationship between the classification of a megaregion's freight spatial network and the connectivity of its intramega standardized freight flows. The top three standardized flows by population and economic productivity include a galactic (Midwest), hub-focused (Texas Triangle), and a dyad (Cascadia) classification, while the bottom three include a galactic (Southern California) and two dyad megaregions (Front Range and Arizona Sun Corridor). Rankings of flows standardized by area also have a mixture of network types near both the top and bottom of the rankings.

4.6 Non-megaregion Areas and the International Market

As the focus of this study, megaregions have received the majority of attention, and non-megaregion-areas and the international market have mostly just been part of this discussion as side actors. These two groupings of airports make up a significant portion of the T-100 dataset, and have been shown to play large roles in many of the megaregions' flow networks. Their impact is not disregarded, and this section focuses on the role these two collections of airports play in the U.S. megaregion system.

It must first be acknowledged that non-megaregion areas and the international market are not geographical entities. They are solely the remainder of space not associated with megaregions, and thus it is would not considered a spatial entity under the viewpoint of geographers. Non-megaregion areas are the collection of space in the U.S. that is not within a megaregion, including airport facilities in Alaska and Hawaii. This area does have a calculable land area, population, and economy because it is the remainder of the country outside the megaregions. The international market does not have any identifiable attributes of area, population, or economy. It is solely made up of all the airports that have connected to the U.S., and between passenger and/or freight flows occurred.

4.6.1 Non-megaregion Areas

4.6.1.1 Passenger Traffic

The gross passenger flows amongst the areas outside of megaregions are equivalent to those of the most active megaregions in passenger travel. Based on the land area, population, and economy of non-megaregion areas, this flow of passengers puts this collective area as the least active in air travel. It is clear that non-megaregion areas lag behind the megaregions in air travel activity, but the relationship to the megaregions is still important to be understood.

The top megaregions with which non-megaregion areas are connected are the Midwest, Piedmont, Texas Triangle, and Northeast. As seen in Figure 4.49, there is a large drop-off after the Midwest, and another drop-off after the Northeast. There also is a large flow internally amongst non-megaregion areas. The least connected megaregions are the Arizona Sun Corridor, Gulf Coast, and Southern Florida. Non-megaregion areas do not have especially high connections internationally, but are on par with most megaregions in terms of where the international market falls in its rankings. The passenger flow connections for non-megaregions areas are show in Table C.23. The standardized flows indicate that the most connected areas are the same as the list for gross volumes; similarly for the least connected areas.

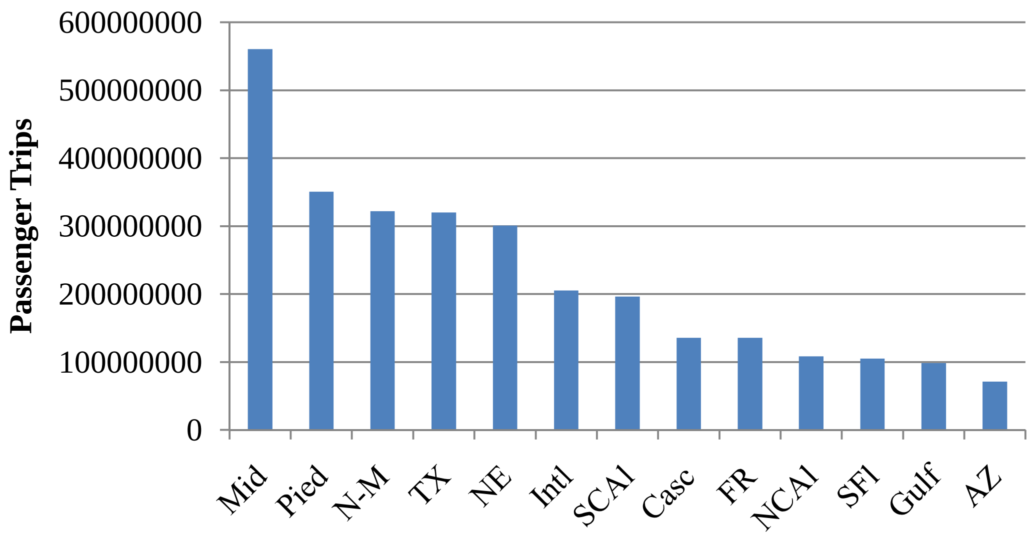

Figure 4.49: Non-megaregion Passenger Flows

Non-megaregion areas have strong internal connections, even when standardized, which shows that this is not solely a megaregion phenomenon. Nine of the eleven megaregions had intramega flows as a significant part of their network, and non-megaregion areas follow suit. The megaregion concept of having greater connectivity within the borders of the megaregion could also be reasoned for non-megaregion areas.

It is interesting to note which megaregions are most connected to non-megaregion areas and which are not. These relationships are hard to define because of the large expanse, varied geography, and diverse populations of non-megaregion areas. What must be taken away is that certain megaregions have attributes that cause them to have a greater connection to areas outside of megaregions. Similarly, the megaregions that are not well connected to non-megaregion areas have characteristics within their population and economy that influence them to have a weaker connection to non-megaregion areas.

4.6.1.2 Freight Traffic

The international market is the highest volume connection for non-megaregion areas, followed by the Midwest and the internal flows of non-megaregion areas. The distribution of flows is displayed in Figure 4.50. These top three are the ones which were consistent for most of the megaregions. The smallest flows for non-megaregion areas are with the Arizona Sun Corridor, Front Range, and Gulf Coast megaregions. The freight flow connections for non-megaregions areas are show in Table C.23.

Non-megaregion areas have a net import of air freight. This is primarily due to their drastic difference in air flows with the international market, over a 40% difference. The only megaregion with which non-megaregion areas import from is Northern California. Otherwise, non-megaregion areas export to ten of the eleven megaregions, with as much as a 34% difference with the Gulf Coast.

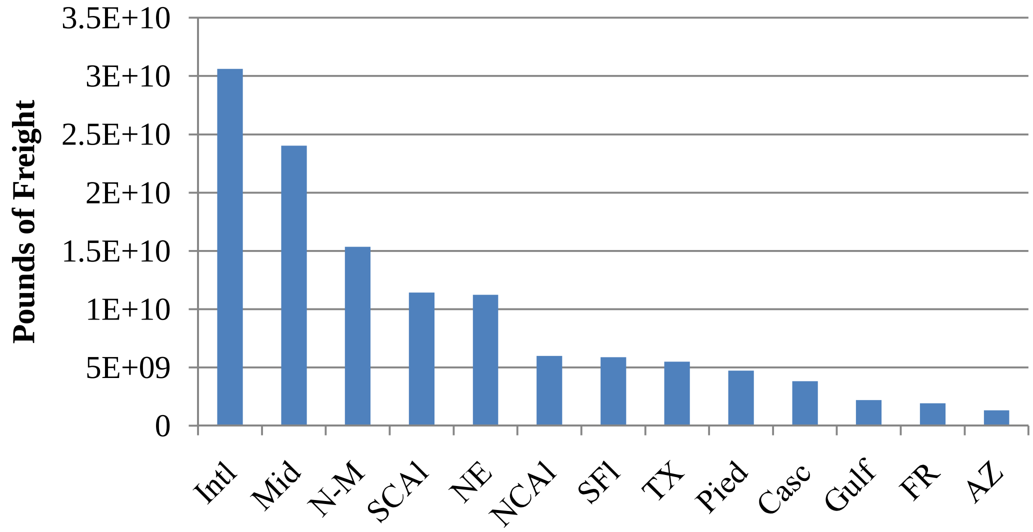

Figure 4.50: Non-megaregion Freight Flows

Standardized flows show the greatest connection for non-megaregion areas is to themselves. The Midwest and Southern California are also strongly connected to non-megaregion areas. The weakest connections are with the Arizona Sun Corridor, Front Range, and Gulf Coast megaregions.

Overall, non-megaregion areas have a significant amount of freight flow to the international market and amongst the airports of non-megaregion areas. The Midwest is a consistent top pair with which all areas are closely tied with, but non-megaregion areas second greatest affinity is with Southern California, one of the major entry points for goods in the U.S. Its lowest connections are with the three megaregions that are consistently not involved in air freight as much as other megaregions: the Front Range, Arizona Sun Corridor, and the Gulf Coast.

4.6.2 International Market

4.6.2.1 Passenger Traffic

The collection of international airports within the T-100 dataset is the international market for this study. The flows to and from these airports to the U.S. are shown in Table C.25. It is seen that the greatest flows are to the Northeast, Southern, Florida, Midwest, and Southern California. As seen in Figure 4.51, the flow with the Northeast is much greater than all other megaregions by a wide margin, indicative of the large connection the Northeast has internationally as opposed to other parts of the country. The other top megaregions are also the gateways into the country, with MIA having a large connection to Latin American in Southern Florida, and LAX doing the same for the Pacific Rim. The Midwest is likely near the top of the list because it has many major large hub airports which handle large volumes of international traffic, such as ORD and DTW. The smallest international connections are with the Arizona Sun Corridor, Front Range, and Cascadia.

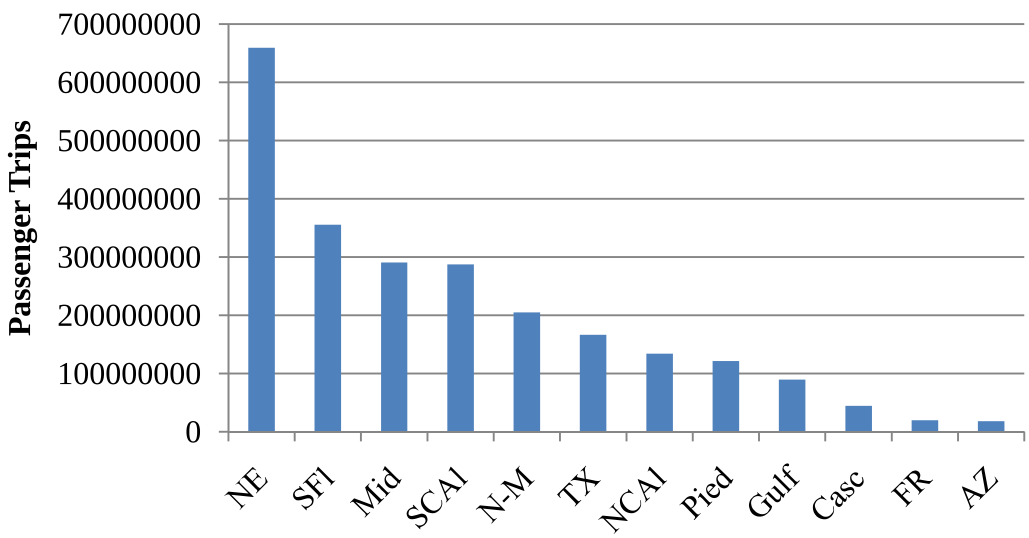

Figure 4.51: International Passenger Flows

4.6.2.2 Freight Traffic

The Northeast, Southern Florida, and the Midwest are the greatest U.S. markets for the collection of international airports in the study. As seen in Figure 4.52, there is a gradual decrease amongst the top connected areas internationally. After Southern California and non-megaregion areas, there is a drop-off to the remaining megaregions. The international markets are least connected to the Arizona Sun Corridor, Front Range, and Cascadia megaregions for freight flows.

Overall, the international market is a net exporter, a large source of air freight for every megaregion. Only with two megaregions does the international market have a net import of flows: the Gulf Coast and Cascadia. The flows to and from the international market for air freight is shown in Table C.26.

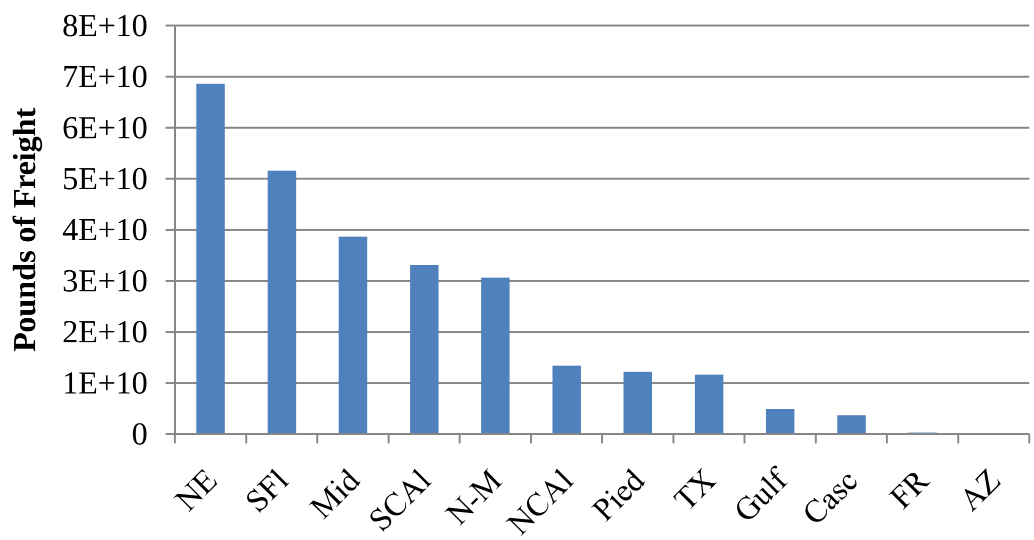

Figure 4.52: International Freight Flows

4.6.3 Summary

Non-megaregion areas are a weak passenger connection for megaregions, but a stronger freight connection. Its internal flows are large for both passenger and freight traffic. There is no clear indication that non-megaregion areas are vastly different from megaregions. They are attracted to some of the largest megaregion in passenger traffic, and have large international flows for freight. Their weakest connections for both passenger and freight are the least established megaregion historically: Front Range, Arizona Sun Corridor, and Gulf Coast.

International flows occur to the megaregions which contain the U.S.'s world cities of New York, Chicago, Los Angeles, and Miami. It is not surprising that the flows are occurring to these areas at the highest rates. The megaregions that contain these cities have business environments which are more globally oriented. The airports in these megaregions are best prepared to receive and process the connections with the international market.

The megaregions' connections with non-megaregion areas and the international market are just as critical as those with other megaregions. It was seen through the previous analyses how these two play an important role in passenger networks for many megaregions, and in the freight networks of almost all megaregions.

4.7 Growth of Megaregion Air Traffic

Demand for air travel and air freight is always changing due to external pressures from the economy and global crises. The U.S. passenger and freight markets overall are steadily growing, despite small drops periodically. This growth is due largely to population and economic growth, with an increasingly mobile population. The following section details how megaregions have played a role in the growth of the U.S. air industry, and how this growth compares to that in non-megaregion areas and in relation to the international market.

In this part of the study, the internal traffic of non-megaregion areas has been broken out to show the differences in this part of the air system over time. Thus non-mega air traffic refers only to flows between megaregions and non-megaregion areas.

4.7.1 Passenger Traffic

Travel within the U.S. passenger system has seen steady growth since 1990, with a dip after 9/11 and another dip during the recession of 2008. Intermega traffic was the largest component of the U.S. system, as seen in Figure 4.53, remaining relatively steady at about 51% of all passenger flows in U.S. airports. The next largest component has been non-mega traffic, although twice in the past 19 years international traffic has almost eclipsed it. The flows internal to megaregions has remained steady, but because of the increase in intermega traffic, the intramega flows have decreased as a percentage of the U.S. flows from about 12.5% to 9%. Within the 19 year time period, overall passenger travel in the U.S. increased by 65%, as seen in Figure 4.54. This growth was greater than the growth of the nation’s GDP (adjusted for inflation), and also significantly greater than the population growth. Table B.11 details all of the growth in passenger traffic over time by type of flow.

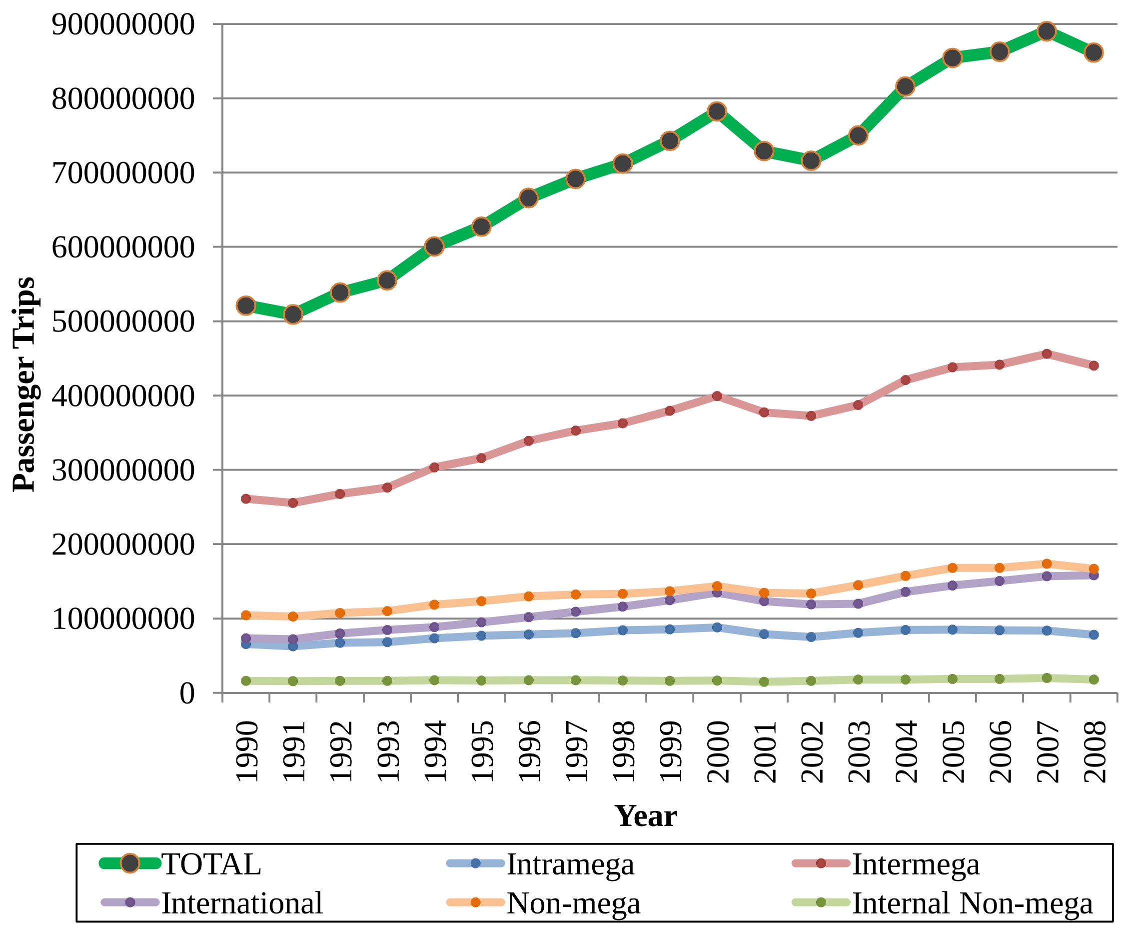

Figure 4.53: Passenger Air Travel Growth

That passenger traffic is growing faster than the economy and the nation's population is attributable to international passenger traffic and the flows between megaregions. Since 1990, international traffic is the fastest growing component of the U.S. system. Despite taking a significant drop post-9/11, it rebounded incredibly fast after 2003, and even grew during the last recession. Figure 4.54 shows that intermega traffic has increased less quickly, but has maintained higher growth than the overall U.S. passenger system. Flows between megaregions and non-megaregion areas have also followed the general growth rates of intermega traffic, but slightly trails overall U.S.

growth. The components of the U.S. passenger system which have lagged behind has been intramega and internal non-mega traffic. Intramega traffic seemed particularly hard hit post-9/11, remaining relative constant while flows leaving the megaregion grew. Internal non-mega traffic actually was the first portion of the U.S. air system to rebound after 9/11, and has performed much better than before 9/11. However, it still struggles to keep up with the size of the U.S. economy and population growth.

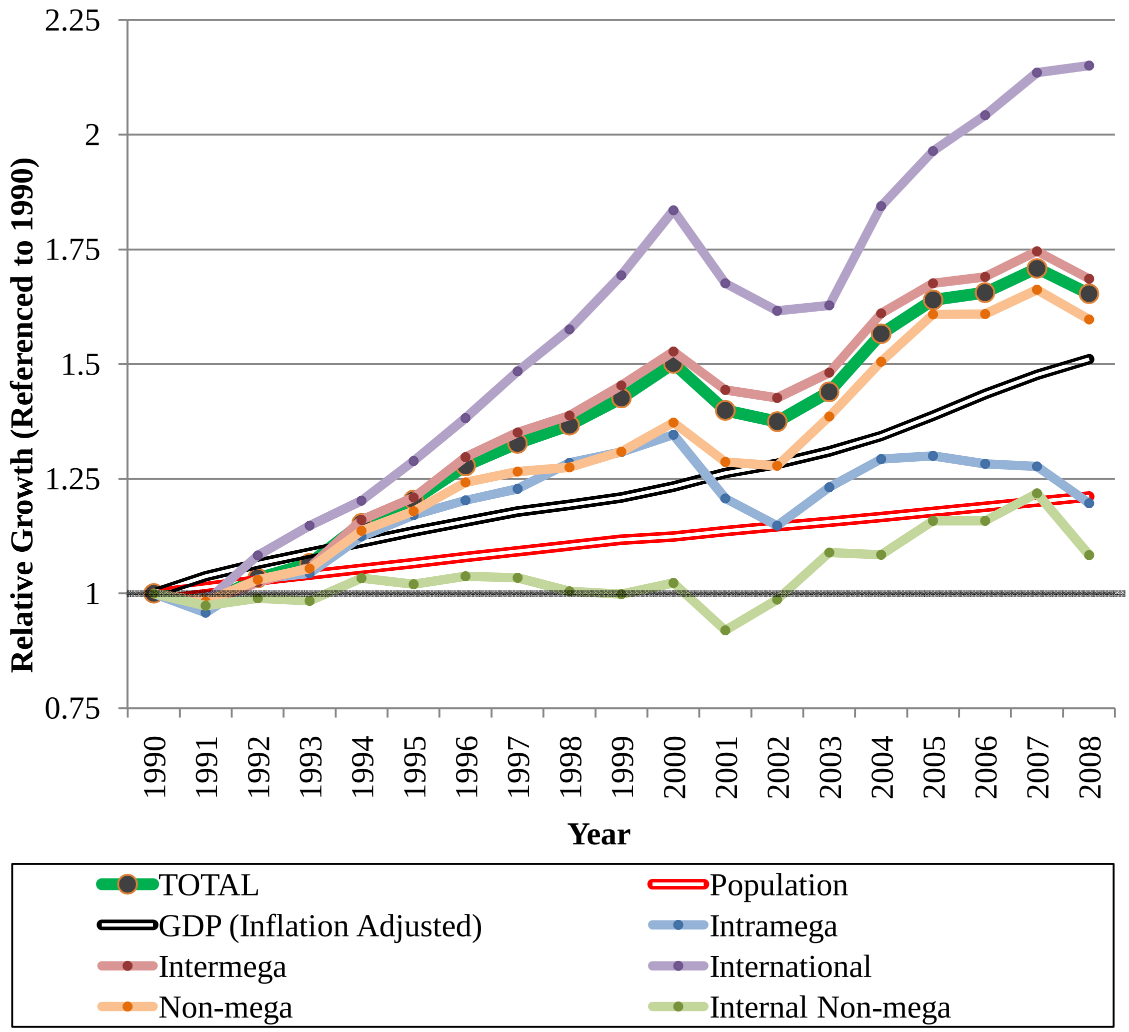

Figure 4.54: Relative Passenger Air Travel Growth

The changing magnitudes of megaregion intramega flows provides insight into how the megaregion's have evolved over time. It is seen that such a small level of inspection, the variation in flows over time is erratic, sometimes varying greatly year to year, as seen in Figure 4.55. All of the megaregions' intramega flows have experienced periods of growth and periods of decline in passenger traffic. The Front Range has had the most drastic changes, rising greatly until 1996, then plummeting until 2002. Northern California has seen swells of growth only to be followed near equal decline.

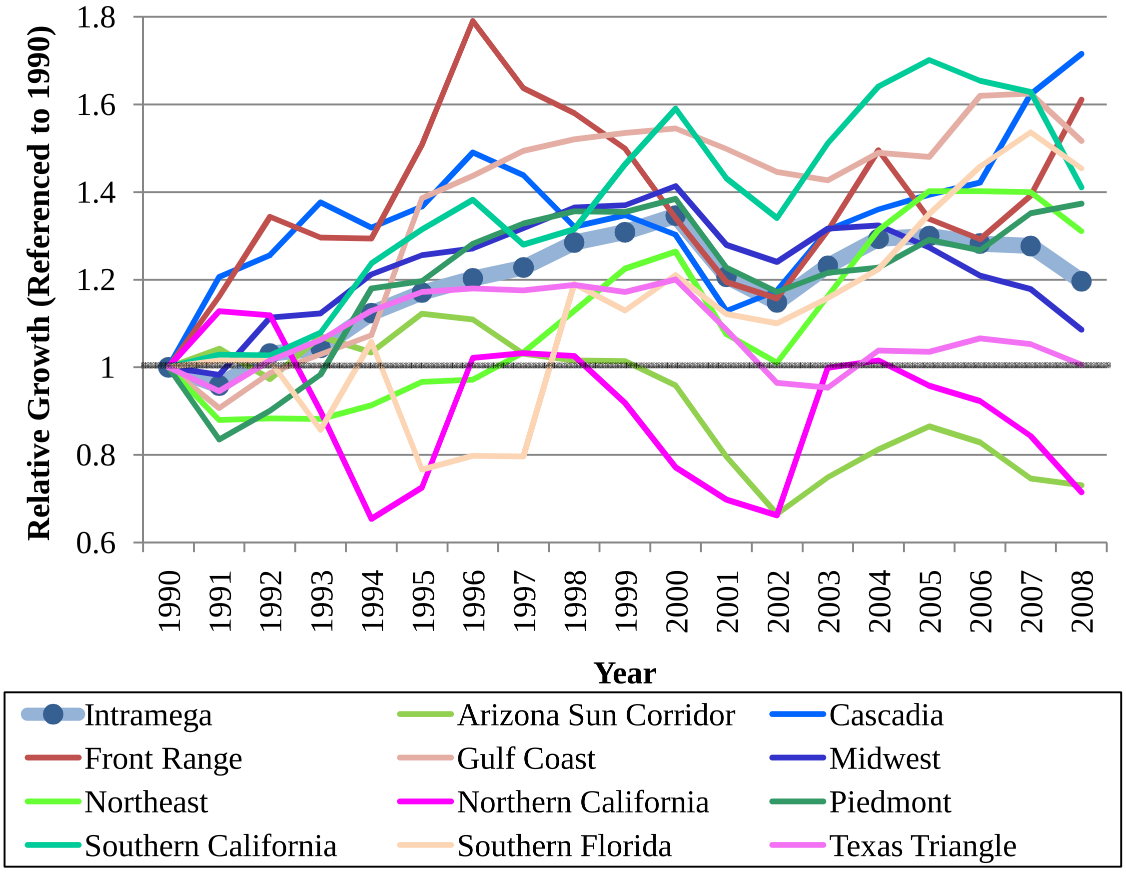

Figure 4.55: Intramega Passenger Flow Growth

The megaregions which had the most steady growth in passenger traffic are Cascadia, Gulf Coast, Front Range, Northeast, Piedmont, Southern California, and Southern Florida megaregions. The Texas Triangle and Midwest both rose slightly in the mid-1990s, but have returned to 1990 levels over the study period. Northern California and the Arizona Sun Corridor have mostly seen decline in intramega passenger flow.

The Front Range, Cascadia, and Piedmont were the least affected by the beginning of the recession, growing from 2007 to 2008, while all other megaregions declined.

The rule changes for T-100 data do not seem to affect the passenger travel statistics greatly. There is no distinguishable jump due to the changes for commuter airlines and small international aircraft when combined with the post-9/11 recovery in air travel. It is reasoned that the rule changes had a minimal effect on the data.

4.7.2 Freight Traffic

Air freight has seen steady growth over time, although this growth has slowed in the middle of the 2000s. Due to the T-100 rule changes that affected domestic all-cargo carriers, there is a drastic jump in the data between 2000 and 2003, as seen in Figure 4.56. International cargo, however, was not affected by this rule change, and can be used as a general descriptor of the nature of air travel during that middle period. There was a dip in air freight due to 9/11 terrorist attacks, but international air freight had recovered by 2002. The economic downturn in 2008 caused air freight to drop in all sectors. Before this time though, intermega and intramega freight flows had already been declining slightly since 2004.

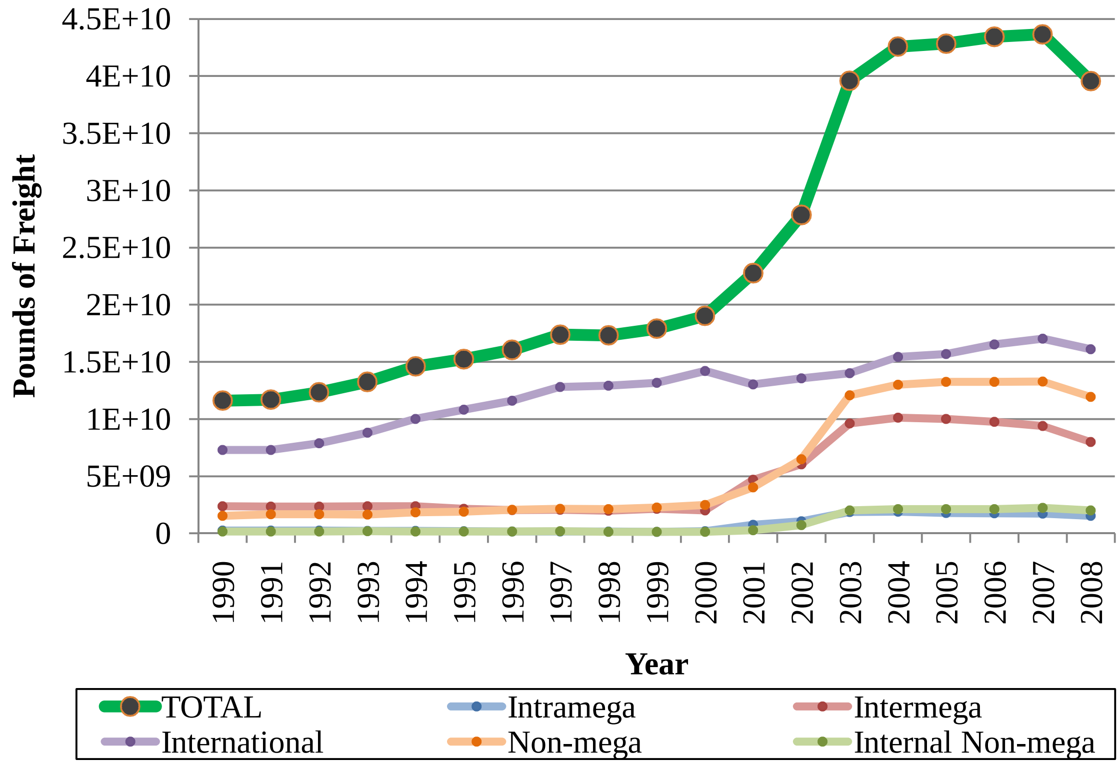

Figure 4.56: Freight Travel Growth Over Time

The rule change period is excluded in the analysis when examining the relative freight flows. With all but international cargo traffic being held to constant relative growth in 2001 and 2002, it is seen which components of the system have grown faster than others. Because all components of the freight system have similar growth patterns pre-2000 and post-2003, as seen in Figure 4.57, it is assumed that the addition of domestic all-cargo, although much greater in magnitude than cargo carried by passenger carriers, did not shift the OD sectors in which air cargo was moving between. It is reasoned that the domestic all-cargo activity pre-2000 was similar to the cargo movements of passenger carriers.

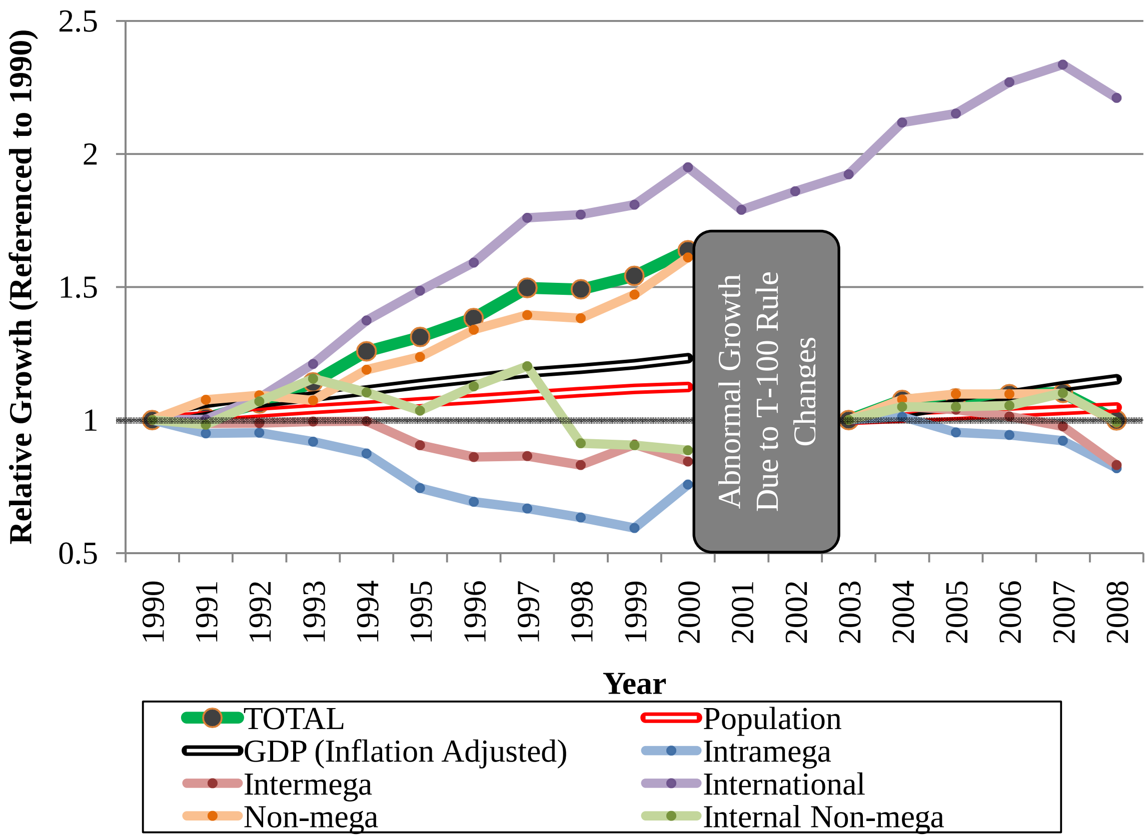

Figure 4.57: Relative Freight Air Travel Growth

International cargo is the largest component of air freight, both before and after the rule changes. Behind is the non-megaregion flows with megaregions, which overtook intermega flows in 1996, and since then only in 2001 has it been lower. Intermega flows over the last several years have been steadily about 75% the volume of non-mega flows. Intramega freight and internal non-mega freight have been relatively small components of air freight. Table B.12 details all of the growth in passenger traffic over time by type of flow.

Examining the relative growth of air freight, it is seen that international cargo has grown the fastest, especially in the post-9/11 era. Only international air cargo is increasing faster than the economy and population growth. Up until 2000, non-mega flows were growing significantly, although the volume of flows has stayed relatively the same since 2004. Internal non-mega flows were declining up until 9/11, and in the era since, increased at the same rate as non-mega flows, although has not yet retained its pre-1990 levels, with an overall decline during the study period. Intramega and intermega flows have seen general declines in air freight since 1990.

The intramega flows for each megaregion did not all follow the same trend during neither the pre-2000 period or post-2003 period. Before 2000, intramega air freight flows were in general on the decline, as seen in Figure 4.58. Three megaregions, the Northeast,

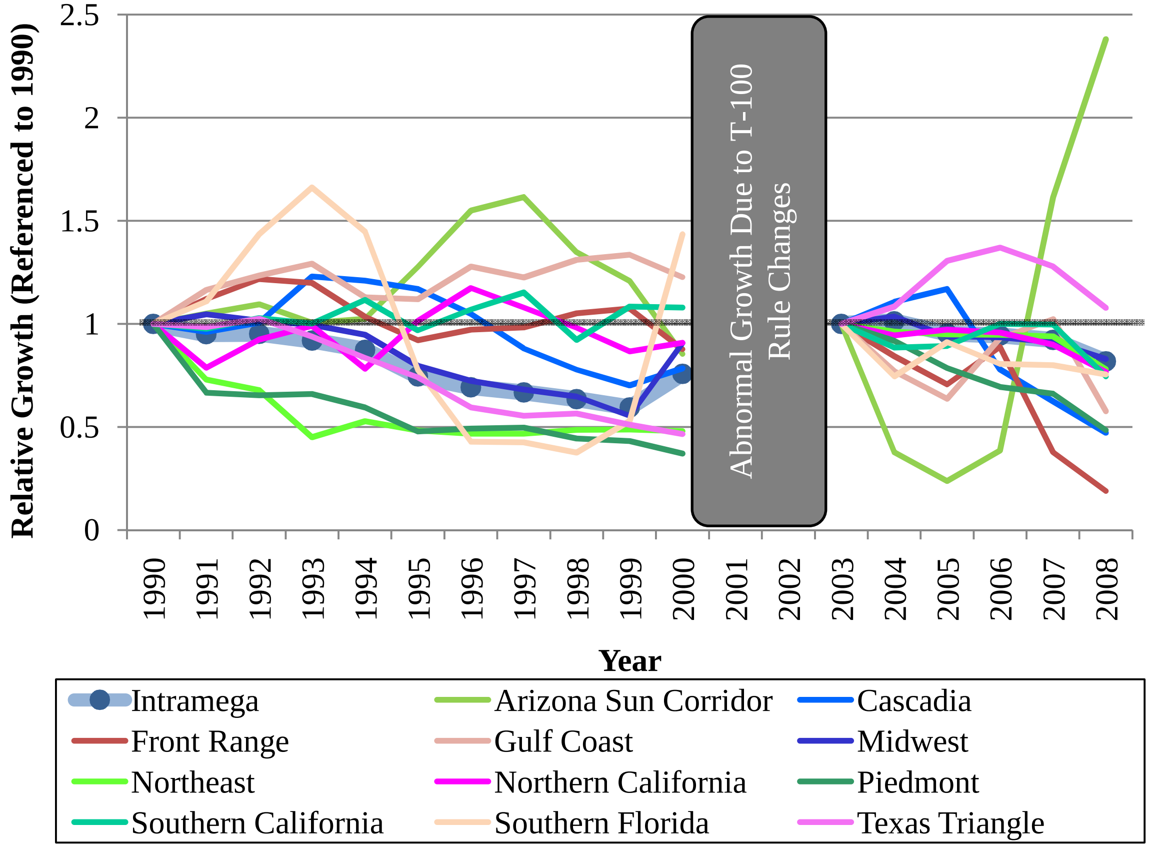

Figure 4.58: Intramega Freight Flow Growth

Piedmont, and Texas Triangle had intramega freight flows half of what they were in 1990. Southern Florida, Midwest, and Cascadia also looked to have decreasing intramega flows until increasing in 1999. Several megaregions had relatively similar intramega flows throughout the decade: the Front Range and the California megaregions. Arizona looked to be on the rise for more than half the decade, before dropping significantly in 1997. Only the Gulf Coast had a general rise in air freight from 1990-2000.

After 9/11, and the reporting rules change, intramega flows declined for all but two megaregions. The hardest hit was the Front Range, dropping over 75% in a span of five years. Cascadia, the Gulf Coast, and the Piedmont dropped drastically as well. Only two megaregions had gains over the post 9/11 period. The Texas Triangle rose about 40% until dropping into the recession. Very oddly, the Arizona Sun Corridor had a roller coaster of intramega flows from 2003-2008. Dropping nearly 75% in 2 years, and then increasing ten-fold from 2005 to 2008.

4.7.3 Intramega Traffic Growth: Case Study on Piedmont Megaregion

4.7.3.1 Passenger Traffic

The Piedmont megaregion two large hubs, ALT and CLT, have seen a steady amount of traffic between each other from 1990 to 2004. As seen in Figure 4.59, starting in 2004 passenger trips increased significantly though, nearly doubling in three years. The largest component within the Piedmont megaregion is the traffic between the medium, small, and non-hub primary airports to the large hubs of ATL and CLT. This sector had a drop post-9/11, and has remained level since that time, although still much higher than in 1990.

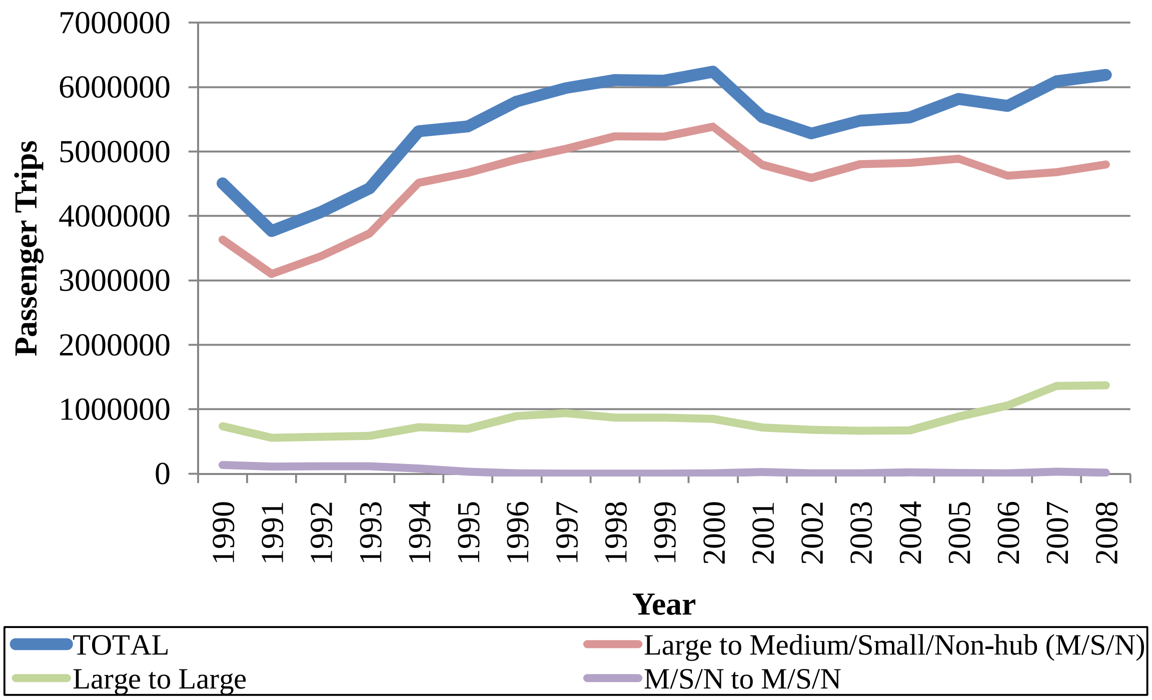

Figure 4.59: Piedmont Passenger Air Travel Growth

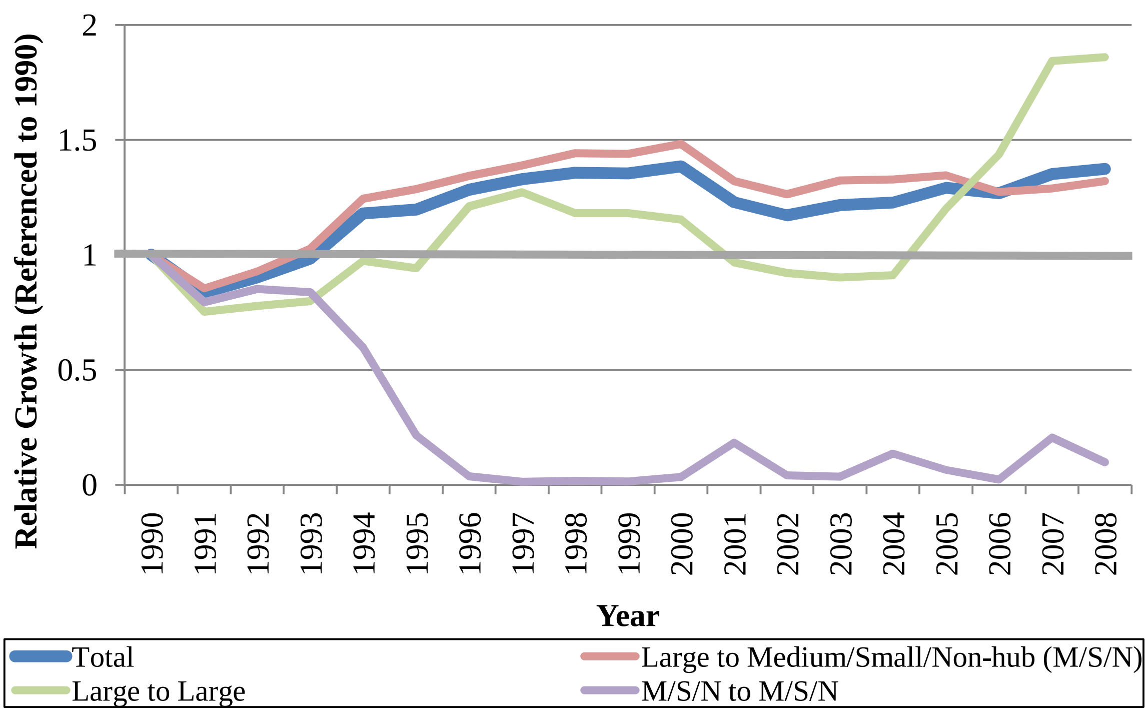

Figure 4.60: Relative Piedmont Passenger Air Travel Growth

Relative to 1990, both the flows between large hubs and from the large hubs to the smaller primary airports increased, as seen in Figure 4.60. The biggest difference over time in the Piedmont megaregion has been the near disappearance of passenger flows between smaller primary airports. Starting in 1993, passenger flows between medium, small, and non-hub airports decreased greatly. During the early 1990s, American Airlines had a hub at RDU and Continental at PTI. By 1995 both of these airlines had retracted their hubbing operations, leaving the airports to have a more supportive role in terms of intermega traffic. No longer did they receive direct routes to the smaller primary airports, and this caused a reduction in traffic between the smaller airports in the megaregion. With the distance across the Piedmont megaregion not being excessively long for air travel, those who would have taken these routings to PTI and RDU likely opted to not travel or drive. Interestingly, there was a simultaneous rise from the smaller primary airports to the large hubs and between the large hubs.

Table C.27 shows the precise passenger volumes for the Piedmont megaregion in each year. Starting in 2002, with the rule changes that affected small certificated and commuter airlines, there is a sudden beginning of flows to and from non-primary airports. The most significant of these is with the large hubs of ATL and CLT. There is negligent traffic to the smaller primary airports as well as between non-primary airports.

4.7.3.2 Freight Traffic

Intramega freight flows in the Piedmont megaregion have been declining since 1990, over 75% during the study period. The rule changes for T-100 caused a small increase in flows, due to the inclusion of domestic all-cargo flights in the dataset, but the decline continued. The freight flows primarily are between large hubs and the smaller primary airports, but this has been the area where the decline has been most prolific, as seen in Figure 4.61. Freight flows between the two large hubs, ATL and CLT, declined until 2001, but have seen an up and down pattern since then, although never reaching 1990 levels, as seen in Figure 4.62. Flows between the smaller primary airports bottomed out from 1997 to 2000. With the rule changes, these smaller airports still showed no improvement after 2003, and generally declined. In terms of the whole system, though, these flows are a very small proportion.

Table C.28 shows the precise freight volumes for the Piedmont megaregion in each year. In 2002, due to the T-100 reporting rule changes, flows to non-primary airports start appearing. This is due to the rule that small certificated airlines now had to

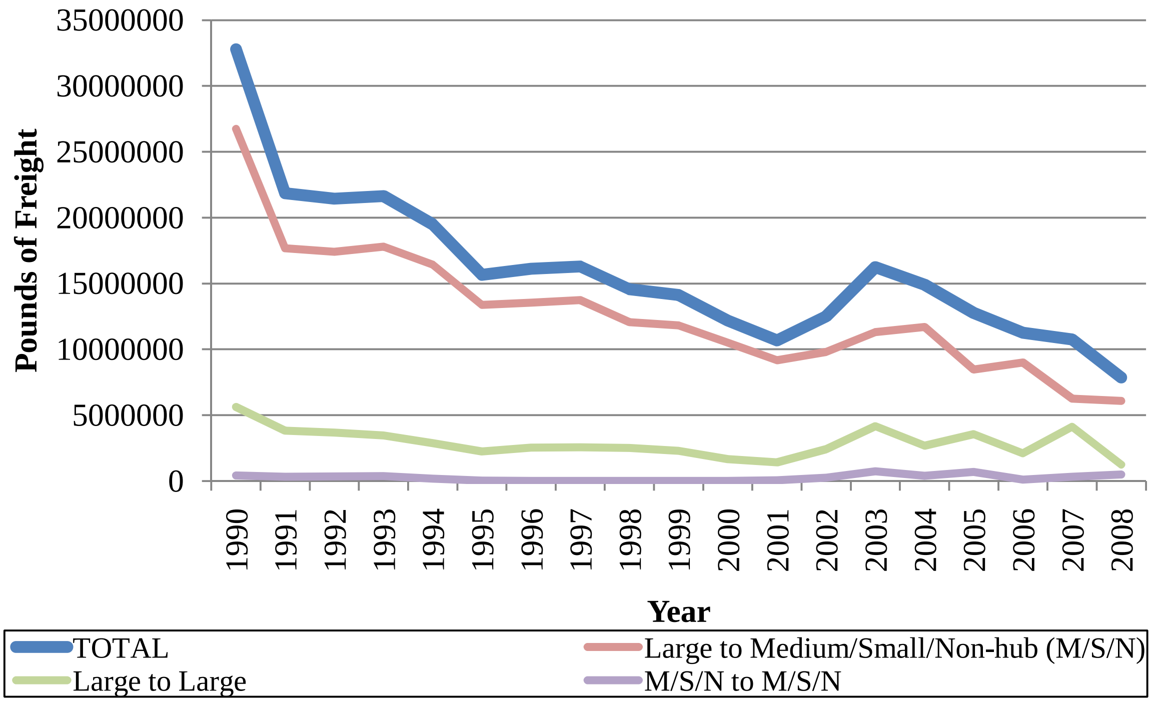

Figure 4.61: Piedmont Freight Air Travel Growth

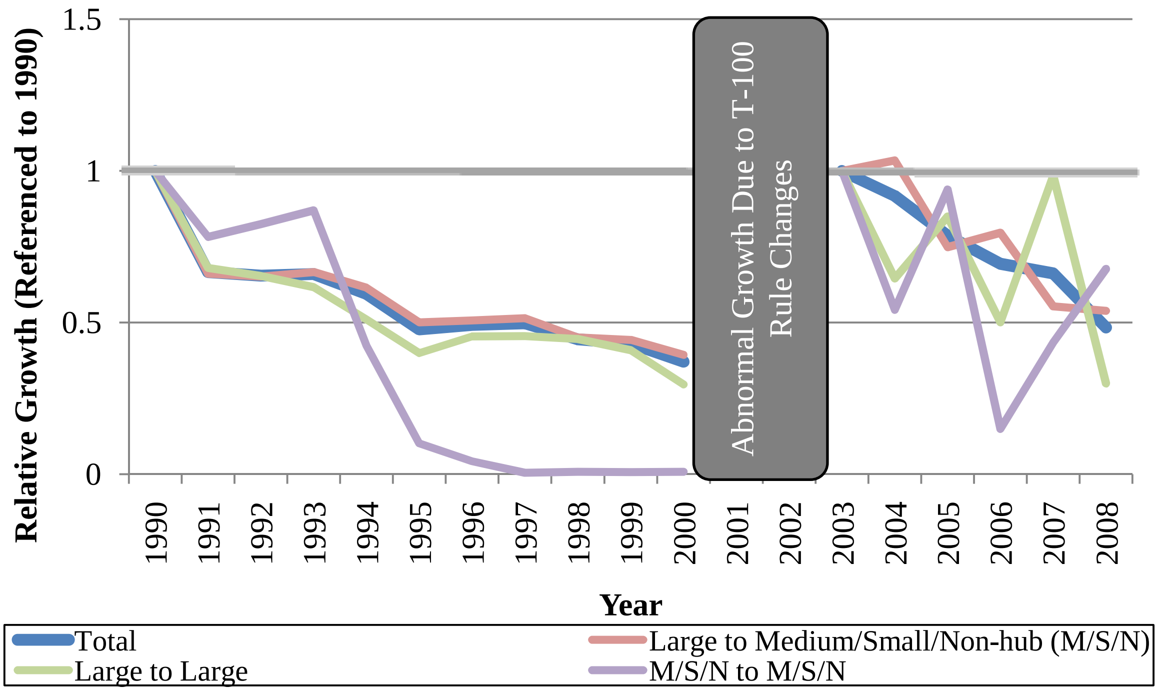

Figure 4.62: Relative Piedmont Freight Air Travel Growth

report their flows, the aircraft that typically cater to non-primary airports. Flows from non-primary airports to large hubs are minute compared to the other flows in the megaregion, and to smaller airports is sporadic and often non-existent.

4.7.4 Summary

Both overall passenger and freight traffic have been increasing since 1990, with their main drop in flows occurring post 9/11. It is important to note that for both sectors, the international components have been the fastest growing. This growth is indicative of the increase in globalization and the importance of interaction between the megaregions and the international market.

The other flow type which is growing for megaregions in both freight and passenger traffic is to non-megaregion areas. The growing connection between the major population and industry centers in the U.S. with the outlying areas indicates the increasing influence megaregions have on the rest of the country. Comparing this flow to intermega traffic reveals more about the situation. For freight, intermega traffic is a sizeable component but dropping. Freight traffic is increasingly not between the megaregions, but to places outside of them, either international or to the rest of the country. In passenger traffic, intermega flows are the largest component and increasing as well. The long distance connection with megaregions, whether to each other or to the outlying areas, is increasing as a whole.

Internal flows are faring poorly both within megaregions and within non-megaregion areas, already small components overall in both sectors. Both of these flow types, although increasing, lag behind in the passenger market behind all other flows. The shorter distance flights have not been able to keep up with the growth in long distance flights. In terms of freight, both are decreasing in prominence, and are smaller overall as compared to 1990. The Piedmont megaregion case study is an example of what is occurring internally within the megaregion. The intramega passenger market has grown to focus more on the large hubs over time, both flows to them and between them, while flows between the smaller primary airports has dropped markedly. In freight traffic, flows between all airports has dropped significantly over time.

CHAPTER 5

CONCLUSIONS

Megaregions are the locations of the nation's largest airports and major airline hubs. Using this infrastructure, megaregion populations engage in strong economies requiring air travel and air freight to socialize, conduct business, and stay connected. The megaregion is large enough that there can be significant internal flows within it, in addition to long distance movements to other megaregions, the areas in between, and internationally. A well planned airport system, integrated successfully into the urban fabric, can enhance the economic productivity and mobility of a megaregion's population and businesses that locate themselves there.

5.1 Key Findings

It is clear that megaregions play a significant role in the U.S. air transport system. The collection of cities and supporting areas in a megaregion have a higher propensity for air travel and shipping air freight, as compared to areas outside the megaregions. This conclusion is not surprising, as the country's cities with the greatest populations are the most active in air travel, and thus the megaregions which contain these cities are fueled by this activity.

A large reason for the megaregion-centric air system is the infrastructure and competitive advantage megaregions have for conducting air travel. The largest most active airports in the country are located within the confines of the megaregions at higher densities as compared to non-megaregion areas. This infrastructure density increases the availability of air facilities for individuals and businesses that require mobility over long distances. Having this access to a large airport thus encourages air travel, and in turn, attracts businesses to the megaregion. The same can be said for airline hubs, of which the megaregions' have the greatest share. The presence of a hub induces travel due to the availability of a large number of direct flights for passengers. Airline hubbing has thus made megaregions more important in air travel than they would be without. Hubs facilitate easier access for megaregion populations to a wider range of destinations. Megaregions have a final advantage in that there is consolidation within their system. There are fewer airports per person in the megaregions, because non-megaregion areas must have a wider spread of air infrastructure and services to provide for the population's dispersal. In megaregions this means there is an increased level of service for a few key airports, inducing airline competition and a conglomeration of supporting services. This in turn, assumingly, reduces the cost of air travel from those airports, making it even easier for megaregion populations to travel and ship. It is not surprising that megaregions are the focal point of the U.S. aviation system.

The connections megaregions have with the international market is significant and is growing in both passenger and freight sectors. The connectivity megaregions have with the international market illustrates their role as the gateways into the country. It is in the megaregions that the nation's global cities reside, interacting through their international airports with the world economy. In both sectors, international traffic has been increasing over the last two decades. Freight especially is seen to be angled internationally, with the top flows out of megaregions headed to international markets. The megaregion's are able to orient themselves internationally more than non-megaregion areas due to the nature of the industries in megaregions, larger service-based economies which frequently require traveling overseas, and the airport infrastructure that is prepared for the international travel.

The internal connections within megaregions are stronger in the passenger sector than it is in the freight sector, although in both it lags behind other flow types in growth. Intramega passenger traffic has some of largest gross volumes of all flows nationwide, especially when the flows are standardized by the respective attributes of the market. Passenger traffic within the megaregion is focused heavily towards the large hubs, seen strongly in megaregions with hub-focused, dyad, and tri-pole spatial flow systems. Intramega freight flows, in general decline over the last two decades, are not generally significant. Only the Midwest, within which is the UPS national hub, has very strong intramega freight flows. It is evident that freight is a movement not typically handled within a megaregion by air. At the smaller distances, it is more economically sound to ship by truck, and thus the market for freight has declined as road systems continually are upgraded. Due to the greater necessity for intramega passenger traffic than freight traffic, the smaller airports in a megaregion often see a greater volume of passenger flows, while the freight traffic is oriented to a few key airports.

In the passenger sector, it is generally seen that megaregions have their strongest connections with the megaregions closest to them. Even at this large scale, crossing state and metropolitan area boundaries, the effects that are described by a gravity model are still seen: distance is important. In the airline industry, costs increases with distance, and this likely has an effect on where passengers are more willing to travel. The four eastern megaregions (Midwest, Northeast, Southern Florida, and Piedmont) are the most traveled grouping of megaregions. The six flow pairings that exist between these megaregions are the most traveled in the nation. Elsewhere, the two California megaregions are very closely tied together, while each individually has a strong flow to its other nearest neighbor: Northern California to Cascadia and Southern California to the Arizona Sun Corridor. The Gulf Coast is closely tied to Southern Florida and the Texas Triangle. The Front Range to the Arizona Sun Corridor and Texas Triangle. Across the board, it seen that in the passenger sector, high passenger flows occur to nearby megaregions.

The distance argument does not apply so easily to freight. In the freight sector, freight hubs play a much more decisive role as to where air freight moves to. Apart from the importance of the international market, freight moves primarily to non-megaregion areas and the Midwest. The argument can be made that these two spaces have large areas, but neither dominated passenger traffic in the way they dominate freight. The Midwest is the first or second highest destination standardizing by pairing attributes for all megaregions. The reason for these effects is the dominance of UPS and FedEx, so much so that it can influence the spatial flows on a megaregion level. With the main UPS hub (Louisville) in the Midwest, and the main FedEx hub (Memphis) in non-megaregion areas, a large portion of the air freight network flows to there. This is even seen on the intramega level, as exemplified by the influence Ontario Airport has on the Southern California network due to its UPS hub status.

The megaregion model certainly has an application to aviation and a governance structure could be created to address megaregion issues. Capacity issues at the country’s largest airports, all located in megaregions, are restraining the possibility for growth. The megaregion could serve as the spatial form over which infrastructure investment decisions are made. If a balancing of demands at airports is necessary within a megaregion to provide a better functioning system, optimizing at the megaregion level could be necessary. An institution at the megaregion level would be needed to handle such a delicate process, managing the interests of public and private airports and the airlines. Using the information on the growth of the different flow types, airports planning could be performed so the megaregion system improves, and not just one airport at the expense of others.

5.2 Future Directions

This study has been an exploration into the interaction between the aviation system and megaregions. In a sense, it is an exploratory study, the first of its kind, to find out the state of air traffic between the U.S. megaregions. The analyses focused on the attributes of the megaregions, simply ranking them against each other for comparison, and profiling each megaregion to understand where its traffic heads, and what happens internally. This research project can be furthered with a strong statistical analysis, to find more about what causes stronger megaregion flows and what factors are influencing growth.

One addition to this study that could improve the assessment of the megaregion situation is to evaluate the capacity of the megaregion's airports. This study focuses solely on the demand for megaregion travel, but to effectively address how megaregions must meet the demand, the current capacity must be known. Several studies have made use of the OAG to calculate the capacity of an airport, and this could be done to calculate it for an entire megaregion. In doing so, it would be able to be determined what megaregions are strained for slots and which have room for growth.

Another addition to this study that could be useful is the introduction of the value and type of goods being shipped by air freight. Volume of freight is certainly important, but air freight is particularly known for shipping high value goods, as compared to truck, railroads, or sea shipping. The cost per mile to ship a valuable good is a smaller part of the good's cost, and it becomes suitable to ship by air. This has not been captured in this study, and is an important feature of air shipments. In addition, knowledge of the type of good would give insight into the type of industry making use of the mode. The inclusion of this in the study, using data from the commodity flow survey, would add depth to the discussion on air freight. This could further answer the question of the role of air movements in megaregion freight traffic.

The spatial analysis of the flows between megaregions should be looked into further with tests commonly found in a geographer's toolkit. The first step should be to run a spatial interaction model between the eleven megaregions. Determining how much distance is a factor is key to determining more about the nature of aviation in regards to megaregions. The output of such a model should be analyzed to see how they deviate from what really is occurring. A principal component analysis could be performed to compare the effects of megaregion attribute data on both the intramega and intermega flows.

Techniques to look more into the nature of the connections would give a more through look at the relationships megaregions have with each other. One spatial analysis procedure is a hierarchal cluster analysis (employed by Choi, Barnett, and Chon 2000), which results in the natural groupings that spatial entities have with each other. Using an OD matrix table as an input, the output can be viewed as a diagram that shows the ordering of places which have the greatest tie. Another geographical technique is a clique analysis (employed by Shin and Timberlake 2000), which employs a range of centrality measures. This method finds groupings of spaces that have a tendency to interact more closely with each other than all other areas, creating a clique of spaces. It allows the functional tendencies that exist in the hierarchy to be displayed.

There is further work to be done in understanding the airline's role in shaping the patterns of a megaregion. In freight transport, the influence of UPS and FedEx on megaregion flows could be further studied to see the precise roles the airlines play in changing a freight network over time. Legacy passenger carriers could be analyzed to see the differences in having different types of hubbing activities in a megaregion and the effect it has on intramega and intermega traffic of that airline.

This study provides insight into how the U.S. megaregion functions within the aviation network, but more could be learned from other worldwide megaregions. The European Union and China have very active air networks and also have experienced a trend towards megaregion formation. Studying their airport flows between and within megaregions over time could aid in determining what affects megaregional air traffic levels.

How airports can be expanded and managed to serve megaregions in the future is affected by their current effectiveness to meet demand. Air facilities will face increased pressure to meet the challenge of a global economy that requires easy connections, and an inability to serve such a function may result in a competitive disadvantage. The megaregion model could be used to manage the upcoming growth.

APPENDIX A

STUDY AIRPORTS

Table A.1: Airports in T-100 Database Used in Study

IATA Code	Airport Name	State	Megaregion	FAA Hub
01A	PURKEYPILE	AK		
04A	FRANK SIKES	AL		
09A	BUTLER-CHOCTAW COUNTY	AL		
1G4	GRAND CANYON WEST	AZ		N
1N7	BLAIRSTOWN	NJ	NE	
A05	DIXIE USFS	ID		
A09	EAGLE AIRPARK	AZ		
A13	BOLD	AK		
A14	PORTAGE CREEK	AK		
A20	SUN VALLEY	AZ		
A23	SAGINAW	AK		
A24	CALIFORNIA PINES	CA		
A26	ADIN	CA		
A27	SELDOVIA	AK		
A28	FORT BIDWELL	CA		
A29	SITKA	AK		
A30	SCOTT VALLEY	CA		
A36	HADLEY	NV		
A43	TAKU HARBOR	AK		
A51	COSTIN	FL		
A57	ALSEK RIVER	AK		
A61	TUNTUTULIAK	AK		
A63	TWIN HILLS	AK		
A67	HARLEQUIN LAKE	AK		
A69	TANIS MESA	AK		
A79	CHIGNIK LAKE	AK		
AAF	APALACHICOLA REGIONAL	FL		
ABE	LEHIGH VALLEY INTL	PA	NE	S
ABI	ABILENE RGNL	TX		N
ABL	AMBLER	AK		
ABQ	ALBUQUERQUE INTL SUNPORT	NM	FR	M

Table A.1 (continued)

ABR	ABERDEEN RGNL	SD		N
ABY	SOUTHWEST GEORGIA RGNL	GA		N
ACB	ANTRIM COUNTY	MI		
ACK	NANTUCKET MEMORIAL	MA	NE	N
ACT	WACO RGNL	TX	TX	N
ACV	ARCATA	CA		N
ACY	ATLANTIC CITY INTL	NJ	NE	S
ADK	ADAK	AK		
ADM	ARDMORE MUNI	OK		
ADQ	KODIAK	AK		N
ADS	ADDISON	TX	TX	
ADW	ANDREWS AFB	MD	NE	
AEX	ALEXANDRIA INTL	LA	Gulf	N
AFW	FORT WORTH ALLIANCE	TX	TX	
AGC	ALLEGHENY COUNTY	PA	Mid	
AGN	ANGOON	AK		
AGS	AUGUSTA RGNL AT BUSH FIELD	GA		N
AHN	ATHENS/BEN EPPS	GA	Pied	
AIA	ALLIANCE MUNI	NE		
AID	ANDERSON MUNI-DARLINGTON FIELD	IN	Mid	
AIK	AIKEN MUNI	SC		
AIZ	LEE C FINE MEMORIAL	MO		
AKI	AKIAK	AK		
AKK	AKHIOK	AK		
AKN	KING SALMON	AK		N
AKO	COLORADO PLAINS RGNL	CO		
AKP	ANAKTUVUK PASS	AK		
ALB	ALBANY INTL	NY		S
ALM	ALAMOGORDO-WHITE SANDS RGNL	NM		
ALN	ST LOUIS RGNL	IL	Mid	
ALO	WATERLOO RGNL	IA		N
ALS	SAN LUIS VALLEY RGNL/BERGMAN FIELD	CO		
ALW	WALLA WALLA RGNL	WA		N
ALX	THOMAS C RUSSELL FLD	AL		
ALZ	ALITAK	AK		
AMA	RICK HUSBAND AMARILLO INTL	TX		S
AMW	AMES MUNI	IA		
ANB	ANNISTON METROPOLITAN	AL	Pied	
ANC	TED STEVENS ANCHORAGE INTL	AK		M
AND	ANDERSON RGNL	SC	Pied	

Table A.1 (continued)

ANI	ANIAK	AK		N
ANN	ANNETTE ISLAND	AK		
ANP	LEE	MD	NE	
ANV	ANVIK	AK		
AOH	LIMA ALLEN COUNTY	OH	Mid	
AOO	ALTOONA-BLAIR COUNTY	PA	Mid	
APA	CENTENNIAL	CO	FR	
APC	NAPA COUNTY	CA	NCAl	
APF	NAPLES MUNI	FL	SFl	N
APG	PHILLIPS AAF	MD	NE	
APN	ALPENA COUNTY RGNL	MI		
APV	APPLE VALLEY	CA	SCal	
AQY	GIRDWOOD	AK		
ARA	ACADIANA RGNL	LA	Gulf	
ARB	ANN ARBOR MUNI	MI	Mid	
ARC	ARCTIC VILLAGE	AK		
ARG	WALNUT RIDGE RGNL	AR		
ART	WATERTOWN INTL	NY		
ARV	LAKELAND/NOBLE F. LEE MEMORIAL FIELD	WI		
ASE	ASPEN-PITKIN CO/SARDY FIELD	CO		N
ASH	BOIRE FIELD	NH	NE	
ASL	HARRISON COUNTY	TX	TX	
ASN	TALLADEGA MUNI	AL	Pied	
AST	ASTORIA RGNL	OR	Casc	
ASX	JOHN F KENNEDY MEMORIAL	WI		
ATK	ATQASUK EDWARD BURNELL SR MEMORIAL	AK		
ATL	HARTSFIELD - JACKSON ATLANTA INTL	GA	Pied	L
ATS	ARTESIA MUNI	NM		
ATU	CASCO COVE CGS	AK		
ATW	OUTAGAMIE COUNTY RGNL	WI	Mid	N
ATY	WATERTOWN RGNL	SD		
AUG	AUGUSTA STATE	ME		
AUK	ALAKANUK	AK		
AUM	AUSTIN MUNI	MN		
AUN	AUBURN MUNI	CA	NCAl	
AUO	AUBURN-OPELIKA ROBERT G. PITTS	AL		
AUS	AUSTIN-BERGSTROM INTL	TX	TX	M
AVL	ASHEVILLE RGNL	NC	Pied	N
AVP	WILKES-BARRE/SCRANTON INTL	PA	NE	N
AWK	WAKE ISLAND AIRFIELD	WQ		

Table A.1 (continued)

AWM	WEST MEMPHIS MUNI	AR		
AXN	CHANDLER FIELD	MN		
AXV	NEIL ARMSTRONG	OH	Mid	
AYS	WAYCROSS-WARE COUNTY	GA		
AZA	PHOENIX-MESA GATEWAY	AZ	AZ	
AZO	KALAMAZOO/BATTLE CREEK INTL	MI	Mid	N
BAB	BEALE AFB	CA	NCAl	
BAD	BARKSDALE AFB	LA		
BAF	BARNES MUNI	MA	NE	
BCE	BRYCE CANYON	UT		
BCT	BOCA RATON	FL	SFl	
BDG	BLANDING MUNI	UT		
BDL	BRADLEY INTL	CT	NE	M
BDR	IGOR I SIKORSKY MEMORIAL	CT	NE	
BED	LAURENCE G HANSCOM FLD	MA	NE	N
BEH	SOUTHWEST MICHIGAN RGNL	MI	Mid	
BET	BETHEL	AK		N
BFD	BRADFORD RGNL	PA	Mid	
BFF	WESTERN NEB. RGNL/WILLIAM B. HEILIG FIELD	NE		N
BFI	BOEING FIELD/KING COUNTY INTL	WA	Casc	N
BFK	BUFFALO MUNI	OK		
BFL	MEADOWS FIELD	CA	SCal	N
BFM	MOBILE DOWNTOWN	AL	Gulf	
BFR	VIRGIL I GRISSOM MUNI	IN	Mid	
BGD	HUTCHINSON COUNTY	TX		
BGM	GREATER BINGHAMTON/EDWIN A LINK FIELD	NY		N
BGQ	BIG LAKE	AK		
BGR	BANGOR INTL	ME		S
BHB	HANCOCK COUNTY-BAR HARBOR	ME		N
BHM	BIRMINGHAM-SHUTTLESWORTH INTL	AL	Pied	S
BID	BLOCK ISLAND STATE	RI	NE	
BIF	BIGGS AAF (FORT BLISS)	TX		
BIG	ALLEN AAF	AK		
BIH	EASTERN SIERRA RGNL	CA		
BIL	BILLINGS LOGAN INTL	MT		S
BIS	BISMARCK MUNI	ND		N
BIX	KEESLER AFB	MS	Gulf	
BJC	ROCKY MOUNTAIN METROPOLITAN	CO	FR	
BJI	BEMIDJI RGNL	MN		N
BJJ	WAYNE COUNTY	OH	Mid	

Table A.1 (continued)

BKE	BAKER CITY MUNI	OR		
BKF	BUCKLEY AFB	CO	FR	
BKL	BURKE LAKEFRONT	OH	Mid	
BKW	RALEIGH COUNTY MEMORIAL	WV		
BKX	BROOKINGS RGNL	SD		
BLD	BOULDER CITY MUNI	NV	SCal	N
BLF	MERCER COUNTY	WV		
BLI	BELLINGHAM INTL	WA	Casc	N
BLM	MONMOUTH EXECUTIVE	NJ	NE	
BLV	SCOTT AFB/MIDAMERICA	IL	Mid	N
BMC	BRIGHAM CITY	UT		
BMG	MONROE COUNTY	IN	Mid	
BMI	CENTRAL IL REGL ARPT AT BLOOMINGTON-NORMAL	IL	Mid	N
BNA	NASHVILLE INTL	TN		M
BNF	WARM SPRING BAY	AK		
BNO	BURNS MUNI	OR		
BOI	BOISE AIR TERMINAL/GOWEN FLD	ID		S
BOK	BROOKINGS	OR		
BOS	GENERAL EDWARD LAWRENCE LOGAN INTL	MA	NE	L
BOW	BARTOW MUNI	FL	SFl	
BPT	SOUTHEAST TEXAS RGNL	TX	TX/Gulf	N
BQK	BRUNSWICK GOLDEN ISLES	GA	SFl	N
BQN	RAFAEL HERNANDEZ	PR		N
BQV	BARTLETT COVE	AK		
BRD	BRAINERD LAKES RGNL	MN		N
BRL	SOUTHEAST IOWA RGNL	IA		
BRO	BROWNSVILLE/SOUTH PADRE ISLAND INTL	TX	Gulf	N
BRW	WILEY POST-WILL ROGERS MEMORIAL	AK		N
BRY	SAMUELS FIELD	KY	Mid	
BTI	BARTER ISLAND LRRS	AK		
BTL	W K KELLOGG	MI	Mid	
BTM	BERT MOONEY	MT		N
BTP	BUTLER COUNTY/K W SCHOLTER FIELD	PA	Mid	
BTR	BATON ROUGE METROPOLITAN, RYAN FIELD	LA	Gulf	S
BTT	BETTLES	AK		
BTV	BURLINGTON INTL	VT		S
BTY	BEATTY	NV		
BUF	BUFFALO NIAGARA INTL	NY		M
BUR	BOB HOPE	CA	SCal	M

Table A.1 (continued)

BVX	BATESVILLE RGNL	AR		
BVY	BEVERLY MUNI	MA	NE	
BWD	BROWNWOOD RGNL	TX		
BWG	BOWLING GREEN-WARREN COUNTY RGNL	KY		
BWI	BALTIMORE/WASHINGTON INTL THURGOOD MARSHAL	MD	NE	L
BYA	BOUNDARY	AK		
BYG	JOHNSON COUNTY	WY		
BYH	ARKANSAS INTL	AR		
BYI	BURLEY MUNI	ID		
BZN	GALLATIN FIELD	MT		N
C01	SOUTHERN CROSS	NJ	NE	
C02	GRAND GENEVA RESORT	WI	Mid	
CAD	WEXFORD COUNTY	MI		
CAE	COLUMBIA METROPOLITAN	SC		S
CAK	AKRON-CANTON RGNL	OH	Mid	S
CAR	CARIBOU MUNI	ME		
CBE	GREATER CUMBERLAND RGNL	MD		
CBM	COLUMBUS AFB	MS		
CCR	BUCHANAN FIELD	CA	NCAl	
CDB	COLD BAY	AK		
CDC	CEDAR CITY RGNL	UT		
CDH	HARRELL FIELD	AR		
CDR	CHADRON MUNI	NE		
CDV	MERLE K (MUDHOLE) SMITH	AK		N
CDW	ESSEX COUNTY	NJ	NE	
CEC	JACK MC NAMARA FIELD	CA		N
CEF	WESTOVER ARB/METROPOLITAN	MA	NE	
CEM	CENTRAL	AK		
CEU	OCONEE COUNTY RGNL	SC	Pied	
CEV	METTEL FIELD	IN	Mid	
CEW	BOB SIKES	FL	Gulf	
CEZ	CORTEZ MUNI	CO		
CFT	GREENLEE COUNTY	AZ		
CFV	COFFEYVILLE MUNI	KS		
CGA	CRAIG	AK		
CGE	CAMBRIDGE-DORCHESTER	MD		
CGF	CUYAHOGA COUNTY	OH	Mid	
CGI	CAPE GIRARDEAU RGNL	MO		
CGS	COLLEGE PARK	MD	NE	

Table A.1 (continued)

CGZ	CASA GRANDE MUNI	AZ	AZ	
CHA	LOVELL FIELD	TN		N
CHD	CHANDLER MUNI	AZ	AZ	
CHL	CHALLIS	ID		
CHO	CHARLOTTESVILLE-ALBEMARLE	VA		N
CHP	CIRCLE HOT SPRINGS	AK		
CHS	CHARLESTON AFB/INTL	SC		S
CHU	HOUSTON COUNTY	MN	Mid	
CIC	CHICO MUNI	CA		N
CID	THE EASTERN IOWA	IA		S
CIK	CHALKYITSIK	AK		
CIN	ARTHUR N NEU	IA		
CIU	CHIPPEWA COUNTY INTL	MI		N
CKB	NORTH CENTRAL WEST VIRGINIA	WV		
CKU	CORDOVA MUNI	AK		
CKV	OUTLAW FIELD	TN		
CKX	CHICKEN	AK		
CLD	MC CLELLAN-PALOMAR	CA	SCal	N
CLE	CLEVELAND-HOPKINS INTL	OH	Mid	M
CLF	CLEAR SKY LODGE	AK		
CLK	CLINTON RGNL	OK		
CLL	EASTERWOOD FIELD	TX	TX	N
CLM	WILLIAM R FAIRCHILD INTL	WA	Casc	N
CLP	CLARKS POINT	AK		
CLR	CLIFF HATFIELD MEMORIAL	CA	SCal	
CLT	CHARLOTTE/DOUGLAS INTL	NC	Pied	L
CLU	COLUMBUS MUNI	IN	Mid	
CMH	PORT COLUMBUS INTL	OH	Mid	M
CMI	UNIVERSITY OF ILLINOIS-WILLARD	IL	Mid	N
CMX	HOUGHTON COUNTY MEMORIAL	MI		N
CNM	CAVERN CITY AIR TRML	NM		
CNO	CHINO	CA	SCal	
CNW	TSTC WACO	TX	TX	
CNY	CANYONLANDS FIELD	UT		
COD	YELLOWSTONE RGNL	WY		N
COE	COEUR D'ALENE - PAPPY BOYINGTON FIELD	ID		
COF	PATRICK AFB	FL	SFl	
COM	COLEMAN MUNI	TX		
CON	CONCORD MUNI	NH	NE	
COS	CITY OF COLORADO SPRINGS MUNI	CO	FR	S

Table A.1 (continued)

COT	COTULLA-LA SALLE COUNTY	TX		
COU	COLUMBIA RGNL	MO		N
CPR	NATRONA COUNTY INTL	WY		N
CPS	ST LOUIS DOWNTOWN	IL	Mid	
CPX	BENJAMIN RIVERA NORIEGA	PR		
CQW	CHERAW MUNI/LYNCH BELLINGER FIELD	SC		
CRE	GRAND STRAND	SC		
CRG	CRAIG MUNI	FL	SFl	
CRP	CORPUS CHRISTI INTL	TX	Gulf	S
CRW	YEAGER	WV		N
CSG	COLUMBUS METROPOLITAN	GA		N
CSM	CLINTON-SHERMAN	OK		
CSV	CROSSVILLE MEMORIAL-WHITSON FIELD	TN		
CTB	CUT BANK MUNI	MT		
CUB	COLUMBIA OWENS DOWNTOWN	SC		
CVG	CINCINNATI/NORTHERN KENTUCKY INTL	KY	Mid	L
CVN	CLOVIS MUNI	NM		
CVO	CORVALLIS MUNI	OR	Casc	
CVS	CANNON AFB	NM		
CWA	CENTRAL WISCONSIN	WI	Mid	N
CWI	CLINTON MUNI	IA		
CXC	CHITINA	AK		
CXF	COLDFOOT	AK		
CXL	CALEXICO INTL	CA	SCal	
CXO	LONE STAR EXECUTIVE	TX	TX/Gulf	
CYM	CHATHAM	AK		
CYS	CHEYENNE RGNL/JERRY OLSON FIELD	WY	FR	N
CYT	YAKATAGA	AK		
CZF	CAPE ROMANZOF LRRS	AK		
CZN	CHISANA	AK		
DAB	DAYTONA BEACH INTL	FL	SFl	N
DAL	DALLAS LOVE FIELD	TX	TX	M
DAN	DANVILLE RGNL	VA		
DAY	JAMES M COX DAYTON INTL	OH	Mid	S
DBN	W H 'BUD' BARRON	GA		
DBQ	DUBUQUE RGNL	IA	Mid	N
DCA	RONALD REAGAN WASHINGTON NATIONAL	DC	NE	L
DCK	DAHL CREEK	AK		
DCU	PRYOR FIELD RGNL	AL	Pied	
DDC	DODGE CITY RGNL	KS		

Table A.1 (continued)

DEC	DECATUR	IL	Mid	N
DEN	DENVER INTL	CO	FR	L
DET	COLEMAN A. YOUNG MUNI	MI	Mid	
DFW	DALLAS/FORT WORTH INTL	TX	TX	L
DHN	DOTHAN RGNL	AL		N
DHT	DALHART MUNI	TX		
DIK	DICKINSON - THEODORE ROOSEVELT RGNL	ND		
DKK	CHAUTAUQUA COUNTY/DUNKIRK	NY		
DLF	LAUGHLIN AFB	TX		
DLG	DILLINGHAM	AK		N
DLH	DULUTH INTL	MN		N
DMA	DAVIS MONTHAN AFB	AZ	AZ	
DMO	SEDALIA MEMORIAL	MO		
DNL	DANIEL FIELD	GA		
DNN	DALTON MUNI	GA		
DNV	VERMILION COUNTY	IL	Mid	
DOV	DOVER AFB	DE	NE	
DPA	DUPAGE	IL	Mid	
DPG	MICHAEL AAF (DUGWAY PROVING GROUND)	UT		
DQH	DOUGLAS MUNI	GA		
DRA	DESERT ROCK	NV		
DRO	DURANGO-LA PLATA COUNTY	CO		N
DRT	DEL RIO INTL	TX		N
DSM	DES MOINES INTL	IA		S
DTL	DETROIT LAKES-WETHING FIELD	MN		
DTO	DENTON MUNI	TX	TX	
DTW	DETROIT METROPOLITAN WAYNE COUNTY	MI	Mid	L
DUC	HALLIBURTON FIELD	OK		
DUG	BISBEE DOUGLAS INTL	AZ	AZ	
DUJ	DUBOIS RGNL	PA	Mid	
DUT	UNALASKA	AK		N
DVL	DEVILS LAKE RGNL	ND		
DVN	DAVENPORT MUNI	IA	Mid	
DVT	PHOENIX DEER VALLEY	AZ	AZ	
DWA	YOLO COUNTY	CA	NCAl	
DWH	DAVID WAYNE HOOKS MEMORIAL	TX	TX/Gulf	
DXR	DANBURY MUNI	CT	NE	
DYS	DYESS AFB	TX		
EAA	EAGLE	AK		
EAR	KEARNEY RGNL	NE		

Table A.1 (continued)

EAT	PANGBORN MEMORIAL	WA		N
EAU	CHIPPEWA VALLEY RGNL	WI	Mid	N
ECG	ELIZABETH CITY CG AIR STATION/RGNL	NC		
EDE	NORTHEASTERN RGNL	NC		
EDF	ELMENDORF AFB	AK		
EDW	EDWARDS AFB	CA	SCal	
EEK	EEK	AK		
EEN	DILLANT-HOPKINS	NH		
EFD	ELLINGTON FIELD	TX	TX/Gulf	
EFK	NEWPORT STATE	VT		
EGE	EAGLE COUNTY RGNL	CO	FR	N
EGX	EGEGIK	AK		
EHM	CAPE NEWENHAM LRRS	AK		
EHR	HENDERSON CITY-COUNTY	KY		
EIL	EIELSON AFB	AK		
EKA	MURRAY FIELD	CA		
EKO	ELKO RGNL	NV		N
EKX	ADDINGTON FIELD	KY	Mid	
EKY	BESSEMER	AL	Pied	
ELD	SOUTH ARKANSAS RGNL AT GOODWIN FIELD	AR		
ELI	ELIM	AK		
ELM	ELMIRA/CORNING RGNL	NY		N
ELN	BOWERS FIELD	WA	Casc	
ELP	EL PASO INTL	TX		S
ELV	ELFIN COVE	AK		
ELY	ELY ARPT /YELLAND FLD/	NV		
EMK	EMMONAK	AK		N
EMM	KEMMERER MUNI	WY		
ENA	KENAI MUNI	AK		N
END	VANCE AFB	OK		
ENN	NENANA MUNI	AK		
ENV	WENDOVER	UT		N
ENW	KENOSHA RGNL	WI	Mid	
EOK	KEOKUK MUNI	IA		
EPH	EPHRATA MUNI	WA		
ERI	ERIE INTL/TOM RIDGE FIELD	PA	Mid	N
ESC	DELTA COUNTY	MI		N
ESF	ESLER RGNL	LA	Gulf	
ESN	EASTON/NEWNAM FIELD	MD		
EUG	MAHLON SWEET FIELD	OR	Casc	N

Table A.1 (continued)

EVM	EVELETH-VIRGINIA MUNI	MN		
EVV	EVANSVILLE RGNL	IN		N
EWB	NEW BEDFORD RGNL	MA	NE	N
EWK	NEWTON-CITY-COUNTY	KS		
EWN	CRAVEN COUNTY RGNL	NC		N
EWR	NEWARK LIBERTY INTL	NJ	NE	L
EXI	EXCURSION INLET	AK		
EYW	KEY WEST INTL	FL	SFl	N
FAI	FAIRBANKS INTL	AK		S
FAR	HECTOR INTL	ND		N
FAT	FRESNO YOSEMITE INTL	CA	NCAl	S
FAY	FAYETTEVILLE RGNL/GRANNIS FIELD	NC	Pied	N
FBK	LADD AAF	AK		
FCH	FRESNO CHANDLER EXECUTIVE	CA	NCAl	
FDK	FREDERICK MUNI	MD	NE	
FDR	FREDERICK MUNI	OK		
FDY	FINDLAY	OH	Mid	
FEP	ALBERTUS	IL	Mid	
FET	FREMONT MUNI	NE		
FFM	FERGUS FALLS MUNI-EINAR MICKELSON FLD	MN		
FFO	WRIGHT-PATTERSON AFB	OH	Mid	
FFT	CAPITAL CITY	KY	Mid	
FHU	SIERRA VISTA MUNI-LIBBY AAF	AZ	AZ	
FKL	VENANGO RGNL	PA	Mid	
FL3	VOSIKA'S	FL		
FLD	FOND DU LAC COUNTY	WI	Mid	
FLG	FLAGSTAFF PULLIAM	AZ		N
FLL	FORT LAUDERDALE/HOLLYWOOD INTL	FL	SFl	L
FLO	FLORENCE RGNL	SC		N
FLT	FLAT	AK		
FMH	CAPE COD COAST GUARD AIR STATION	MA	NE	
FMN	FOUR CORNERS RGNL	NM		N
FMY	PAGE FIELD	FL	SFl	
FNL	FORT COLLINS-LOVELAND MUNI	CO	FR	N
FNR	FUNTER BAY	AK		
FNT	BISHOP INTL	MI	Mid	S
FOD	FORT DODGE RGNL	IA		
FOE	FORBES FIELD	KS		N
FOK	FRANCIS S GABRESKI	NY	NE	
FPR	ST LUCIE COUNTY INTL	FL	SFl	

Table A.1 (continued)

FQD	RUTHERFORD CO - MARCHMAN FIELD	NC	Pied	
FRD	FRIDAY HARBOR	WA	Casc	N
FRG	REPUBLIC	NY	NE	
FSD	JOE FOSS FIELD	SD		S
FSM	FORT SMITH RGNL	AR		N
FTW	FORT WORTH MEACHAM INTL	TX	TX	
FTY	FULTON COUNTY AIRPORT-BROWN FIELD	GA	Pied	
FVZ	INIGOK	AK		
FWA	FORT WAYNE INTL	IN	Mid	N
FWL	FAREWELL	AK		
FXE	FORT LAUDERDALE EXECUTIVE	FL	SFl	
FYU	FORT YUKON	AK		
FYV	DRAKE FIELD	AR		
GA2	PEACH STATE	GA		
GAD	NORTHEAST ALABAMA RGNL	AL	Pied	
GAI	MONTGOMERY COUNTY AIRPARK	MD	NE	
GAL	EDWARD G. PITKA SR	AK		N
GAM	GAMBELL	AK		
GBD	GREAT BEND MUNI	KS		
GBG	GALESBURG MUNI	IL	Mid	
GBH	GALBRAITH LAKE	AK		
GBR	WALTER J. KOLADZA	MA		
GCC	GILLETTE-CAMPBELL COUNTY	WY		N
GCK	GARDEN CITY RGNL	KS		N
GCN	GRAND CANYON NATIONAL PARK	AZ		S
GCY	GREENEVILLE-GREENE COUNTY MUNI	TN		
GDM	GARDNER MUNI	MA	NE	
GDV	DAWSON COMMUNITY	MT		
GDW	GLADWIN ZETTEL MEMORIAL	MI	Mid	
GED	SUSSEX COUNTY	DE		
GEG	SPOKANE INTL	WA		S
GEY	SOUTH BIG HORN COUNTY	WY		
GFA	MALMSTROM AFB	MT		
GFK	GRAND FORKS INTL	ND		N
GFL	FLOYD BENNETT MEMORIAL	NY		
GGE	GEORGETOWN COUNTY	SC		
GGG	EAST TEXAS RGNL	TX	TX	N
GGW	WOKAL FIELD/GLASGOW INTL	MT		
GJT	GRAND JUNCTION REGIONAL	CO		N
GKN	GULKANA	AK		

Table A.1 (continued)

GLD	RENNER FLD /GOODLAND MUNI/	KS		
GLH	MID DELTA RGNL	MS		
GLR	GAYLORD RGNL	MI		
GLS	SCHOLES INTL AT GALVESTON	TX	TX/Gulf	
GLW	GLASGOW MUNI	KY		
GMU	GREENVILLE DOWNTOWN	SC	Pied	
GNU	GOODNEWS	AK		
GNV	GAINESVILLE RGNL	FL	SFl	N
GON	GROTON-NEW LONDON	CT	NE	
GPT	GULFPORT-BILOXI INTL	MS	Gulf	S
GPZ	GRAND RAPIDS/ITASCA CO-GORDON NEWSTROM FLD	MN		
GRB	AUSTIN STRAUBEL INTL	WI	Mid	S
GRD	GREENWOOD COUNTY	SC		
GRF	GRAY AAF	WA	Casc	
GRI	CENTRAL NEBRASKA RGNL	NE		
GRK	ROBERT GRAY AAF	TX	TX	N
GRR	GERALD R. FORD INTL	MI	Mid	S
GSB	SEYMOUR JOHNSON AFB	NC	Pied	
GSH	GOSHEN MUNI	IN	Mid	
GSO	PIEDMONT TRIAD INTL	NC	Pied	S
GSP	GREENVILLE SPARTANBURG INTL	SC	Pied	S
GST	GUSTAVUS	AK		N
GTF	GREAT FALLS INTL	MT		N
GTR	GOLDEN TRIANGLE RGNL	MS		N
GUC	GUNNISON-CRESTED BUTTE RGNL	CO		N
GUM	GUAM INTL	GU		S
GUP	GALLUP MUNI	NM		
GUS	GRISSOM ARB	IN	Mid	
GUY	GUYMON MUNI	OK		
GVL	LEE GILMER MEMORIAL	GA	Pied	
GVT	MAJORS	TX	TX	
GWO	GREENWOOD-LEFLORE	MS		
GWR	GWINNER-ROGER MELROE FIELD	ND		
GYR	PHOENIX GOODYEAR	AZ	AZ	
GYY	GARY/CHICAGO INTL	IN	Mid	
HAE	HANNIBAL RGNL	MO		
HAO	BUTLER CO RGNL	OH	Mid	
HBC	MOHALL MUNI	ND		
HBG	HATTIESBURG BOBBY L CHAIN MUNI	MS		

Table A.1 (continued)

HCA	HOLY CROSS	AK		
HDN	YAMPA VALLEY	CO		N
HEZ	HARDY-ANDERS FIELD NATCHEZ-ADAMS COUNTY	MS		
HFD	HARTFORD-BRAINARD	CT	NE	
HGR	HAGERSTOWN RGNL-RICHARD A HENSON FLD	MD	NE	
HHH	HILTON HEAD	SC		N
HIB	CHISHOLM-HIBBING	MN		N
HIE	MOUNT WASHINGTON RGNL	NH		
HIF	HILL AFB	UT		
HII	LAKE HAVASU CITY	AZ		
HIO	PORTLAND-HILLSBORO	OR	Casc	
HKS	HAWKINS FIELD	MS		
HKY	HICKORY RGNL	NC	Pied	
HLG	WHEELING OHIO CO	WV	Mid	
HLM	PARK TOWNSHIP	MI	Mid	
HLN	HELENA RGNL	MT		N
HMN	HOLLOMAN AFB	NM		
HNH	HOONAH	AK		
HNL	HONOLULU INTL	HI		L
HNM	HANA	HI		
HNS	HAINES	AK		
HOB	LEA COUNTY RGNL	NM		
HOM	HOMER	AK		N
HON	HURON RGNL	SD		
HOP	CAMPBELL AAF (FORT CAMPBELL)	KY		
HOT	MEMORIAL FIELD	AR		
HOU	WILLIAM P HOBBY	TX	TX/Gulf	M
HPB	HOOPER BAY	AK		
HPN	WESTCHESTER COUNTY	NY	NE	S
HQM	BOWERMAN	WA	Casc	
HRL	VALLEY INTL	TX	Gulf	S
HRO	BOONE COUNTY	AR		
HSI	HASTINGS MUNI	NE		
HSP	INGALLS FIELD	VA		
HST	HOMESTEAD ARB	FL	SFl	
HSV	HUNTSVILLE INTL-CARL T JONES FIELD	AL	Pied	S
HTO	EAST HAMPTON	NY	NE	
HTS	TRI-STATE/MILTON J. FERGUSON FIELD	WV		N
HUA	REDSTONE AAF	AL	Pied	

Table A.1 (continued)

HUF	TERRE HAUTE INTL-HULMAN FIELD	IN	Mid	
HUL	HOULTON INTL	ME		
HUM	HOUMA-TERREBONNE	LA	Gulf	
HUS	HUGHES	AK		
HUT	HUTCHINSON MUNI	KS		
HVN	TWEED-NEW HAVEN	CT	NE	N
HVR	HAVRE CITY-COUNTY	MT		
HVS	HARTSVILLE RGNL	SC		
HWD	HAYWARD EXECUTIVE	CA	NCAl	
HWI	HAWK INLET	AK		
HYA	BARNSTABLE MUNI-BOARDMAN/POLANDO FIELD	MA	NE	N
HYG	HYDABURG	AK		
HYL	HOLLIS	AK		
HYS	HAYS RGNL	KS		N
IAB	MC CONNELL AFB	KS		
IAD	WASHINGTON DULLES INTL	DC	NE	L
IAG	NIAGARA FALLS INTL	NY		
IAH	GEORGE BUSH INTERCONTINENTAL/HOUSTON	TX	TX/Gulf	L
IAN	BOB BAKER MEMORIAL	AK		
ICT	WICHITA MID-CONTINENT	KS		S
IDA	IDAHO FALLS RGNL	ID		N
IDI	INDIANA COUNTY/JIMMY STEWART FLD/	PA	Mid	
IDP	INDEPENDENCE MUNI	KS		
IFP	LAUGHLIN/BULLHEAD INTL	AZ		N
IGG	IGIUGIG	AK		
IGM	KINGMAN	AZ		
IKK	GREATER KANKAKEE	IL	Mid	
IKO	NIKOLSKI AS	AK		
IKV	ANKENY RGNL	IA		
ILE	SKYLARK FIELD	TX	TX	
ILG	NEW CASTLE	DE	NE	
ILI	ILIAMNA	AK		
ILM	WILMINGTON INTL	NC		N
ILN	AIRBORNE AIRPARK	OH	Mid	
IMT	FORD	MI		
IND	INDIANAPOLIS INTL	IN	Mid	M
INL	FALLS INTL	MN		N
INS	CREECH AFB	NV	SCal	
INT	SMITH REYNOLDS	NC	Pied	

Table A.1 (continued)

INW	WINSLOW-LINDBERGH RGNL	AZ		
IPL	IMPERIAL COUNTY	CA	SCal	N
IPT	WILLIAMSPORT RGNL	PA		N
IRK	KIRKSVILLE RGNL	MO		
IRS	KIRSCH MUNI	MI	Mid	
ISM	KISSIMMEE GATEWAY	FL	SFl	
ISN	SLOULIN FLD INTL	ND		
ISO	KINSTON RGNL JETPORT AT STALLINGS FLD	NC		N
ISP	LONG ISLAND MAC ARTHUR	NY	NE	S
ISQ	SCHOOLCRAFT COUNTY	MI		
ISW	ALEXANDER FIELD SOUTH WOOD COUNTY	WI	Mid	
ITH	ITHACA TOMPKINS RGNL	NY		N
ITO	HILO INTL	HI		S
IWD	GOGEBIC-IRON COUNTY	MI		
IYK	INYOKERN	CA	SCal	N
JAC	JACKSON HOLE	WY		N
JAN	JACKSON-EVERS INTL	MS		S
JAX	JACKSONVILLE INTL	FL	SFl	M
JBR	JONESBORO MUNI	AR		
JEF	JEFFERSON CITY MEMORIAL	MO		
JFK	JOHN F KENNEDY INTL	NY	NE	L
JHM	KAPALUA	HI		
JHW	CHAUTAUQUA COUNTY/JAMESTOWN	NY		
JLA	QUARTZ CREEK	AK		
JLN	JOPLIN RGNL	MO		N
JMS	JAMESTOWN RGNL	ND		
JNU	JUNEAU INTL	AK		S
JQF	CONCORD RGNL	NC	Pied	
JRA	WEST 30TH ST.	NY	NE	
JRB	PORT AUTH-DWNTN-MANHATTAN/WALL ST	NY	NE	
JST	JOHN MURTHA JOHNSTOWN-CAMBRIA CO	PA	Mid	N
JVL	SOUTHERN WISCONSIN RGNL	WI	Mid	
JWN	JOHN C TUNE	TN		
JXN	JACKSON COUNTY-REYNOLDS FIELD	MI	Mid	
JZI	CHARLESTON EXECUTIVE	SC		
K01	FARINGTON FIELD	NE		
KAE	KAKE	AK		
KAL	KALTAG	AK		
KBE	BELL ISLAND HOT SPRINGS	AK		
KCC	COFFMAN COVE	AK		

Table A.1 (continued)

KCL	CHIGNIK LAGOON	AK		
KCN	CHERNOFSKI HARBOR	AK		
KCR	COLORADO CREEK	AK		
KDK	KODIAK MUNI	AK		
KEB	NANWALEK	AK		
KEK	EKWOK	AK		
KFP	FALSE PASS	AK		
KGX	GRAYLING	AK		
KIB	IVANOF BAY	AK		
KKA	KOYUK ALFRED ADAMS	AK		
KKB	KITOI BAY	AK		
KKI	AKIACHAK	AK		
KKL	KARLUK LAKE	AK		
KKU	EKUK	AK		
KLG	KALSKAG	AK		
KMY	MOSER BAY	AK		
KNB	KANAB MUNI	UT		
KNW	NEW STUYAHOK	AK		
KOA	KONA INTL AT KEAHOLE	HI		S
KOY	OLGA BAY	AK		
KPB	POINT BAKER	AK		
KPC	PORT CLARENCE CGS	AK		
KPR	PORT WILLIAMS	AK		
KPY	PORT BAILEY	AK		
KQA	AKUTAN	AK		
KSM	ST MARY'S	AK		N
KTB	THORNE BAY	AK		
KTN	KETCHIKAN INTL	AK		N
KTS	BREVIG MISSION	AK		
KVC	KING COVE	AK		
KVL	KIVALINA	AK		
KWF	WATERFALL	AK		
KWK	KWIGILLINGOK	AK		
KWP	WEST POINT VILLAGE	AK		
KWT	KWETHLUK	AK		
KXA	KASAAN	AK		
KYK	KARLUK	AK		
KYU	KOYUKUK	AK		
LAA	LAMAR MUNI	CO		
LAF	PURDUE UNIVERSITY	IN	Mid	

Table A.1 (continued)

LAL	LAKELAND LINDER RGNL	FL	SFl	
LAM	LOS ALAMOS	NM	FR	
LAN	CAPITAL CITY	MI	Mid	N
LAR	LARAMIE RGNL	WY		N
LAS	MC CARRAN INTL	NV	SCal	L
LAW	LAWTON-FORT SILL RGNL	OK		N
LAX	LOS ANGELES INTL	CA	SCal	L
LBB	LUBBOCK PRESTON SMITH INTL	TX		S
LBE	ARNOLD PALMER RGNL	PA	Mid	N
LBF	NORTH PLATTE RGNL AIRPORT LEE BIRD FIELD	NE		
LBL	LIBERAL MID-AMERICA RGNL	KS		
LCH	LAKE CHARLES RGNL	LA	Gulf	N
LCI	LACONIA MUNI	NH		
LCK	RICKENBACKER INTL	OH	Mid	
LEB	LEBANON MUNI	NH		N
LEE	LEESBURG INTL	FL	SFl	
LEW	AUBURN/LEWISTON MUNI	ME		
LEX	BLUE GRASS	KY	Mid	S
LFI	LANGLEY AFB	VA		
LFK	ANGELINA COUNTY	TX	TX	
LFT	LAFAYETTE RGNL	LA	Gulf	N
LGA	LA GUARDIA	NY	NE	L
LGB	LONG BEACH /DAUGHERTY FIELD/	CA	SCal	S
LGC	LAGRANGE-CALLAWAY	GA		
LGD	LA GRANDE/UNION COUNTY	OR		
LGU	LOGAN-CACHE	UT		
LHB	HEARNE MUNI	TX	TX	
LHQ	FAIRFIELD COUNTY	OH	Mid	
LHV	WILLIAM T. PIPER MEMORIAL	PA		
LIH	LIHUE	HI		S
LIT	ADAMS FIELD	AR		S
LJN	BRAZORIA COUNTY	TX	TX/Gulf	
LKE	KENMORE AIR HARBOR	WA	Casc	
LKK	KULIK LAKE	AK		
LKV	LAKE COUNTY	OR		
LMT	KLAMATH FALLS	OR		N
LNK	LINCOLN	NE		N
LNS	LANCASTER	PA	NE	
LNY	LANAI	HI		N
LOU	BOWMAN FIELD	KY	Mid	

Table A.1 (continued)

LOZ	LONDON-CORBIN ARPT-MAGEE FLD	KY		
LPC	LOMPOC	CA	SCal	
LQK	PICKENS COUNTY	SC	Pied	
LRD	LAREDO INTL	TX		N
LRF	LITTLE ROCK AFB	AR		
LRU	LAS CRUCES INTL	NM		
LSE	LA CROSSE MUNI	WI	Mid	N
LSF	LAWSON AAF (FORT BENNING)	GA		
LSR	LOST RIVER 1	AK		
LSV	NELLIS AFB	NV	SCal	
LTS	ALTUS AFB	OK		
LUF	LUKE AFB	AZ	AZ	
LUK	CINCINNATI MUNI AIRPORT LUNKEN FIELD	OH	Mid	
LUL	HESLER-NOBLE FIELD	MS		
LUP	KALAUPAPA	HI		
LUR	CAPE LISBURNE LRRS	AK		
LVK	LIVERMORE MUNI	CA	NCAl	
LVM	MISSION FIELD	MT		
LWB	GREENBRIER VALLEY	WV		N
LWC	LAWRENCE MUNI	KS		
LWM	LAWRENCE MUNI	MA	NE	
LWS	LEWISTON-NEZ PERCE COUNTY	ID		N
LWT	LEWISTOWN MUNI	MT		
LWV	LAWRENCEVILLE-VINCENNES INTL	IL		
LXN	JIM KELLY FIELD	NE		
LYH	LYNCHBURG RGNL/PRESTON GLENN FLD	VA		N
LZU	GWINNETT COUNTY - BRISCOE FIELD	GA	Pied	
MAC	MACON DOWNTOWN	GA		
MAE	MADERA MUNI	CA	NCAl	
MAF	MIDLAND INTL	TX		S
MAW	MALDEN MUNI	MO		
MAZ	EUGENIO MARIA DE HOSTOS	PR		
MBL	MANISTEE CO.-BLACKER	MI		
MBS	MBS INTL	MI	Mid	N
MCB	MC COMB/PIKE COUNTY/JOHN E LEWIS FIELD	MS		
MCC	MC CLELLAN AIRFIELD	CA	NCAl	
MCD	MACKINAC ISLAND	MI		
MCE	MERCED MUNI/MACREADY FIELD	CA	NCAl	
MCF	MAC DILL AFB	FL	SFl	
MCG	MC GRATH	AK		

Table A.1 (continued)

MCI	KANSAS CITY INTL	MO		M
MCK	MC COOK RGNL	NE		
MCN	MIDDLE GEORGIA RGNL	GA		N
MCO	ORLANDO INTL	FL	SFl	L
MCW	MASON CITY MUNI	IA		N
MDD	MIDLAND AIRPARK	TX		
MDH	SOUTHERN ILLINOIS	IL		
MDO	MIDDLETON ISLAND	AK		
MDT	HARRISBURG INTL	PA	NE	S
MDW	CHICAGO MIDWAY INTL	IL	Mid	L
MDY	HENDERSON FIELD	MQ		
MEI	KEY FIELD	MS		N
MEJ	MEADE MUNI	KS		
MEM	MEMPHIS INTL	TN		M
MER	CASTLE	CA	NCAl	
MEV	MINDEN-TAHOE	NV	NCAl	
MEZ	MENA INTERMOUNTAIN MUNI	AR		
MFD	MANSFIELD LAHM RGNL	OH	Mid	
MFE	MC ALLEN MILLER INTL	TX	Gulf	S
MFR	ROGUE VALLEY INTL - MEDFORD	OR		N
MGE	DOBBINS AIR RESERVE BASE (ATLANTA NAS)	GA	Pied	
MGM	MONTGOMERY RGNL (DANNELLY FIELD)	AL		N
MGW	MORGANTOWN MUNI-WALTER L. BILL HART FLD	WV		
MGY	DAYTON-WRIGHT BROTHERS	OH	Mid	
MHE	MITCHELL MUNI	SD		
MHK	MANHATTAN RGNL	KS		N
MHL	MARSHALL MEMORIAL MUNI	MO		
MHM	MINCHUMINA	AK		
MHR	SACRAMENTO MATHER	CA	NCAl	
MHT	MANCHESTER	NH	NE	M
MHV	MOJAVE	CA	SCal	
MIA	MIAMI INTL	FL	SFl	L
MIB	MINOT AFB	ND		
MIE	DELAWARE COUNTY - JOHNSON FIELD	IN	Mid	
MIO	MIAMI MUNI	OK		
MIT	SHAFTER-MINTER FIELD	CA	SCal	
MIV	MILLVILLE MUNI	NJ	NE	
MIW	MARSHALLTOWN MUNI	IA		
MJX	ROBERT J. MILLER AIR PARK	NJ	NE	

Table A.1 (continued)

MKC	CHARLES B. WHEELER DOWNTOWN	MO		
MKE	GENERAL MITCHELL INTL	WI	Mid	M
MKG	MUSKEGON COUNTY	MI	Mid	N
MKK	MOLOKAI	HI		N
MKL	MC KELLAR-SIPES RGNL	TN		
MKT	MANKATO RGNL	MN		
MLB	MELBOURNE INTL	FL	SFl	N
MLI	QUAD CITY INTL	IL	Mid	S
MLS	FRANK WILEY FIELD	MT		
MLT	MILLINOCKET MUNI	ME		
MLU	MONROE RGNL	LA		N
MLY	MANLEY HOT SPRINGS	AK		
MMH	MAMMOTH YOSEMITE	CA		
MMI	MCMINN COUNTY	TN		
MML	SOUTHWEST MINNESOTA RGNL MARSHALL/RYAN FLD	MN		
MMT	MC ENTIRE JNGB	SC		
MMU	MORRISTOWN MUNI	NJ	NE	
MNM	MENOMINEE-MARINETTE TWIN COUNTY	MI		
MNN	MARION MUNI	OH	Mid	
MNZ	HAMILTON MUNI	TX		
MO1	RICHLAND MUNI	MO		
MOB	MOBILE RGNL	AL	Gulf	N
MOD	MODESTO CITY-CO-HARRY SHAM FLD	CA	NCAl	N
MOP	MOUNT PLEASANT MUNI	MI	Mid	
MOR	MOORE-MURRELL	TN		
MOS	MOSES POINT	AK		
MOT	MINOT INTL	ND		N
MOU	MOUNTAIN VILLAGE	AK		
MPR	MC PHERSON	KS		
MPV	EDWARD F KNAPP STATE	VT		
MQT	SAWYER INTL	MI		N
MQY	SMYRNA	TN		
MRB	EASTERN WV RGNL/SHEPHERD FLD	WV	NE	
MRC	MAURY COUNTY	TN		
MRI	MERRILL FIELD	AK		N
MRN	FOOTHILLS RGNL	NC	Pied	
MRY	MONTEREY PENINSULA	CA	NCAl	N
MSL	NORTHWEST ALABAMA RGNL	AL	Pied	
MSN	DANE COUNTY RGNL-TRUAX FIELD	WI	Mid	S

Table A.1 (continued)

MSO	MISSOULA INTL	MT		N
MSP	MINNEAPOLIS-ST PAUL INTL/WOLD-CHAMBERLAIN	MN	Mid	L
MSS	MASSENA INTL-RICHARDS FIELD	NY		
MSV	SULLIVAN COUNTY INTL	NY	NE	
MSY	LOUIS ARMSTRONG NEW ORLEANS INTL	LA	Gulf	M
MTC	SELFRIDGE ANGB	MI	Mid	
MTH	THE FLORIDA KEYS MARATHON	FL	SFl	
MTJ	MONTROSE RGNL	CO		N
MTM	METLAKATLA	AK		
MTN	MARTIN STATE	MD	NE	
MTO	COLES COUNTY MEMORIAL	IL		
MTP	MONTAUK	NY	NE	
MUE	WAIMEA-KOHALA	HI		
MUO	MOUNTAIN HOME AFB	ID		
MUT	MUSCATINE MUNI	IA		
MVL	MORRISVILLE-STOWE STATE	VT		
MVM	MACHIAS VALLEY	ME		
MVN	MOUNT VERNON	IL		
MVY	MARTHAS VINEYARD	MA	NE	N
MWA	WILLIAMSON COUNTY RGNL	IL		N
MWH	GRANT CO INTL	WA		
MWO	HOOK FIELD MUNI	OH	Mid	
MXF	MAXWELL AFB	AL		
MYF	MONTGOMERY FIELD	CA	SCal	
MYK	MAY CREEK	AK		
MYL	MC CALL MUNI	ID		
MYR	MYRTLE BEACH INTL	SC		S
MYU	MEKORYUK	AK		
MZJ	PINAL AIRPARK	AZ	AZ	
MZZ	MARION MUNI	IN	Mid	
N47	POTTSTOWN MUNI	PA	NE	
N87	TRENTON-ROBBINSVILLE	NJ	NE	
NBG	NEW ORLEANS NAS JRB/ALVIN CALLENDER FIELD/	LA	Gulf	
NEW	LAKEFRONT	LA	Gulf	
NFL	FALLON NAS /VAN VOORHIS FLD/	NV		
NGF	KANEOHE BAY MCAF	HI		
NGP	CORPUS CHRISTI NAS/TRUAX FIELD	TX	Gulf	
NGU	NORFOLK NS (CHAMBERS FLD)	VA		
NHK	PATUXENT RIVER NAS/TRAPNELL FIELD/	MD	NE	

Table A.1 (continued)

NHZ	BRUNSWICK NAS	ME		
NIN	NINILCHIK	AK		
NIP	JACKSONVILLE NAS /TOWERS FIELD/	FL	SFl	
NJK	EL CENTRO NAF	CA	SCal	
NKT	CHERRY POINT MCAS /CUNNINGHAM FIELD/	NC		
NKX	MIRAMAR MCAS	CA	SCal	
NLC	LEMOORE NAS (REEVES FLD)	CA	NCAl	
NPA	PENSACOLA NAS/FORREST SHERMAN FIELD/	FL	Gulf	
NQA	MILLINGTON RGNL JETPORT	TN		
NQX	KEY WEST NAS /BOCA CHICA FIELD/	FL	SFl	
NRB	MAYPORT NS (ADM DAVID L. MCDONALD FIELD)	FL	SFl	
NTD	POINT MUGU NAS (NAVAL BASE VENTURA CO)	CA	SCal	
NTU	OCEANA NAS /APOLLO SOUCEK FIELD/	VA		
NUI	WEBSTER NOLF	MD	NE	
NUL	NULATO	AK		
NUQ	MOFFETT FEDERAL AFLD	CA	NCAl	
NUW	WHIDBEY ISLAND NAS /AULT FIELD/	WA	Casc	
NXX	WILLOW GROVE NAS JRB	PA	NE	
NY2	CAMILLUS	NY		
NYL	YUMA MCAS/YUMA INTL	AZ		
NZY	NORTH ISLAND NAS /HALSEY FIELD/	CA	SCal	
OAJ	ALBERT J ELLIS	NC		N
OAK	METROPOLITAN OAKLAND INTL	CA	NCAl	M
OBU	KOBUK	AK		
OCF	OCALA INTL-JIM TAYLOR FIELD	FL	SFl	
OFF	OFFUTT AFB	NE		
OFK	KARL STEFAN MEMORIAL	NE		
OGB	ORANGEBURG MUNI	SC		
OGD	OGDEN-HINCKLEY	UT		
OGG	KAHULUI	HI		M
OGS	OGDENSBURG INTL	NY		
OIC	LT WARREN EATON	NY		
OKC	WILL ROGERS WORLD	OK		S
OKK	KOKOMO MUNI	IN	Mid	
OLF	L M CLAYTON	MT		
OLM	OLYMPIA	WA	Casc	
OLS	NOGALES INTL	AZ	AZ	
OLU	COLUMBUS MUNI	NE		
OLV	OLIVE BRANCH	MS		

Table A.1 (continued)

OMA	EPPLEY AIRFIELD	NE		M
OME	NOME	AK		N
OMK	OMAK	WA		
ONA	WINONA MUNI-MAX CONRAD FLD	MN	Mid	
ONP	NEWPORT MUNI	OR	Casc	
ONT	ONTARIO INTL	CA	SCal	M
OOK	TOKSOOK BAY	AK		
OPF	OPA- LOCKA EXECUTIVE	FL	SFl	
OQN	BRANDYWINE	PA	NE	
ORD	CHICAGO O'HARE INTL	IL	Mid	L
ORF	NORFOLK INTL	VA		M
ORH	WORCESTER RGNL	MA	NE	N
ORI	PORT LIONS	AK		
ORL	EXECUTIVE	FL	SFl	
ORT	NORTHWAY	AK		
OSC	OSCODA-WURTSMITH	MI		
OSH	WITTMAN RGNL	WI	Mid	
OSU	OHIO STATE UNIVERSITY	OH	Mid	
OTG	WORTHINGTON MUNI	MN		
OTH	SOUTHWEST OREGON RGNL	OR		N
OTM	OTTUMWA INDUSTRIAL	IA		
OTZ	RALPH WIEN MEMORIAL	AK		N
OUN	UNIVERSITY OF OKLAHOMA WESTHEIMER	OK		
OWA	OWATONNA DEGNER RGNL	MN	Mid	
OWB	OWENSBORO-DAVIESS COUNTY	KY		
OWD	NORWOOD MEMORIAL	MA	NE	
OXC	WATERBURY-OXFORD	CT	NE	
OXR	OXNARD	CA	SCal	N
PAE	SNOHOMISH COUNTY (PAINE FLD)	WA	Casc	
PAH	BARKLEY RGNL	KY		N
PAK	PORT ALLEN	HI		
PAM	TYNDALL AFB	FL		
PAQ	PALMER MUNI	AK		
PBF	GRIDER FIELD	AR		
PBG	PLATTSBURGH INTL	NY		
PBI	PALM BEACH INTL	FL	SFl	M
PCA	PICACHO STAGEFIELD	AZ	AZ	
PDK	DEKALB-PEACHTREE	GA	Pied	
PDT	EASTERN OREGON RGNL AT PENDLETON	OR		
PDX	PORTLAND INTL	OR	Casc	M

Table A.1 (continued)

PEC	PELICAN	AK		
PFN	PANAMA CITY-BAY CO INTL	FL		N
PGA	PAGE MUNI	AZ		N
PGD	CHARLOTTE COUNTY	FL	SFl	
PGL	TRENT LOTT INTL	MS	Gulf	
PGM	PORT GRAHAM	AK		
PGV	PITT-GREENVILLE	NC		N
PHD	HARRY CLEVER FIELD	OH	Mid	
PHF	NEWPORT NEWS/WILLIAMSBURG INTL	VA		S
PHL	PHILADELPHIA INTL	PA	NE	L
PHN	ST CLAIR COUNTY INTL	MI	Mid	
PHO	POINT HOPE	AK		
PHT	HENRY COUNTY	TN		
PHX	PHOENIX SKY HARBOR INTL	AZ	AZ	L
PIA	GREATER PEORIA RGNL	IL	Mid	N
PIB	HATTIESBURG-LAUREL RGNL	MS		N
PIE	ST PETERSBURG-CLEARWATER INTL	FL	SFl	N
PIH	POCATELLO RGNL	ID		N
PIM	HARRIS COUNTY	GA		
PIR	PIERRE RGNL	SD		N
PIT	PITTSBURGH INTL	PA	Mid	M
PIZ	POINT LAY LRRS	AK		
PKA	NAPASKIAK	AK		
PKB	MID-OHIO VALLEY RGNL	WV		
PKD	PARK RAPIDS MUNI-KONSHOK FIELD	MN		
PLB	CLINTON CO	NY		
PLK	M. GRAHAM CLARK - TANEY COUNTY	MO		
PLN	PELLSTON RGNL AIRPORT OF EMMET COUNTY	MI		N
PMB	PEMBINA MUNI	ND		
PMD	PALMDALE RGNL/USAF PLANT 42	CA	SCal	
PMH	GREATER PORTSMOUTH RGNL	OH	Mid	
PMU	PANOLA COUNTY	MS		
PNC	PONCA CITY RGNL	OK		
PNE	NORTHEAST PHILADELPHIA	PA	NE	
PNS	PENSACOLA RGNL	FL	Gulf	S
POB	POPE AFB	NC	Pied	
POC	BRACKETT FIELD	CA	SCal	
POU	DUTCHESS COUNTY	NY	NE	
POY	POWELL MUNI	WY		
PPC	PROSPECT CREEK	AK		

Table A.1 (continued)

PPG	PAGO PAGO INTL	AS		N
PQI	NORTHERN MAINE RGNL ARPT AT PRESQUE IS	ME		N
PRB	PASO ROBLES MUNI	CA		
PRC	ERNEST A. LOVE FIELD	AZ	AZ	
PRZ	PORTALES MUNI	NM		
PSB	MID-STATE	PA	Mid	
PSC	TRI-CITIES	WA		N
PSE	MERCEDITA	PR		N
PSF	PITTSFIELD MUNI	MA		
PSG	PETERSBURG JAMES A JOHNSON	AK		N
PSK	NEW RIVER VALLEY	VA		
PSM	PORTSMOUTH INTL AT PEASE	NH	NE	N
PSN	PALESTINE MUNI	TX	TX	
PSP	PALM SPRINGS INTL	CA	SCal	S
PSX	PALACIOS MUNI	TX	TX/Gulf	
PTD	POTSDAM MUNI/DAMON FLD/	NY		
PTH	PORT HEIDEN	AK		
PTK	OAKLAND COUNTY INTL	MI	Mid	
PTS	ATKINSON MUNI	KS		
PTU	PLATINUM	AK		
PTV	PORTERVILLE MUNI	CA	NCAl	
PUB	PUEBLO MEMORIAL	CO	FR	
PUC	CARBON COUNTY RGNL/BUCK DAVIS FIELD	UT		
PUW	PULLMAN/MOSCOW RGNL	WA		N
PVC	PROVINCETOWN MUNI	MA	NE	N
PVD	THEODORE FRANCIS GREEN STATE	RI	NE	M
PVU	PROVO MUNI	UT		
PWA	WILEY POST	OK		
PWK	CHICAGO EXECUTIVE	IL	Mid	
PWM	PORTLAND INTL JETPORT	ME		S
PWT	BREMERTON NATIONAL	WA	Casc	
PYM	PLYMOUTH MUNI	MA	NE	
RAC	JOHN H BATTEN	WI	Mid	
RAP	RAPID CITY RGNL	SD		N
RBD	DALLAS EXECUTIVE	TX	TX	
RBG	ROSEBURG RGNL	OR		
RBL	RED BLUFF MUNI	CA		
RBY	RUBY	AK		
RCA	ELLSWORTH AFB	SD		
RDB	RED DOG	AK		

Table A.1 (continued)

RDD	REDDING MUNI	CA		N
RDG	READING RGNL/CARL A SPAATZ FIELD	PA	NE	
RDM	ROBERTS FIELD	OR		N
RDR	GRAND FORKS AFB	ND		
RDU	RALEIGH-DURHAM INTL	NC	Pied	M
RDV	RED DEVIL	AK		
RED	RED LODGE	MT		
RFD	CHICAGO/ROCKFORD INTL	IL	Mid	N
RHI	RHINELANDER-ONEIDA COUNTY	WI		N
RIC	RICHMOND INTL	VA		S
RID	RICHMOND MUNI	IN	Mid	
RIL	GARFIELD COUNTY RGNL	CO		
RIV	MARCH ARB	CA	SCal	
RIW	RIVERTON RGNL	WY		N
RKD	KNOX COUNTY RGNL	ME		N
RKS	ROCK SPRINGS-SWEETWATER COUNTY	WY		N
RKW	ROCKWOOD MUNI	TN		
RME	GRIFFISS INTL	NY		
RMG	RICHARD B RUSSELL	GA	Pied	
RMP	RAMPART	AK		
RNC	WARREN COUNTY MEMORIAL	TN		
RND	RANDOLPH AFB	TX	TX	
RNO	RENO/TAHOE INTL	NV	NCAl	M
RNT	RENTON MUNI	WA	Casc	
ROA	ROANOKE RGNL/WOODRUM FIELD	VA		N
ROC	GREATER ROCHESTER INTL	NY		S
ROG	ROGERS MUNI-CARTER FIELD	AR		
ROP	ROTA INTL	CQ		N
ROR	BABELTHUAP/KOROR			
ROW	ROSWELL INTL AIR CENTER	NM		
RQI	NIXON FORK MINE	AK		
RRT	WARROAD INTL MEMORIAL	MN		
RSH	RUSSIAN MISSION	AK		
RSN	RUSTON RGNL	LA		
RST	ROCHESTER INTL	MN	Mid	N
RSW	SOUTHWEST FLORIDA INTL	FL	SFl	M
RUT	RUTLAND - SOUTHERN VERMONT RGNL	VT		
RVS	RICHARD LLOYD JONES JR	OK		
RWI	ROCKY MOUNT-WILSON RGNL	NC	Pied	
RWL	RAWLINS MUNI/HARVEY FIELD	WY		

Table A.1 (continued)

SAA	SHIVELY FIELD	WY		
SAC	SACRAMENTO EXECUTIVE	CA	NCAl	
SAD	SAFFORD RGNL	AZ	AZ	
SAF	SANTA FE MUNI	NM	FR	
SAN	SAN DIEGO INTL	CA	SCal	L
SAT	SAN ANTONIO INTL	TX	TX	M
SAV	SAVANNAH/HILTON HEAD INTL	GA		S
SBA	SANTA BARBARA MUNI	CA	SCal	S
SBD	SAN BERNARDINO INTL	CA	SCal	
SBM	SHEBOYGAN COUNTY MEMORIAL	WI	Mid	
SBN	SOUTH BEND RGNL	IN	Mid	S
SBO	EMANUEL COUNTY	GA		
SBP	SAN LUIS COUNTY RGNL	CA		N
SBY	SALISBURY-OCEAN CITY WICOMICO RGNL	MD		N
SCC	DEADHORSE	AK		N
SCE	UNIVERSITY PARK	PA	Mid	N
SCH	SCHENECTADY COUNTY	NY		
SCK	STOCKTON METROPOLITAN	CA	NCAl	N
SCM	SCAMMON BAY	AK		
SDF	LOUISVILLE INTL-STANDIFORD FIELD	KY	Mid	S
SDM	BROWN FIELD MUNI	CA	SCal	
SDP	SAND POINT	AK		
SDY	SIDNEY-RICHLAND MUNI	MT		
SEA	SEATTLE-TACOMA INTL	WA	Casc	L
SEE	GILLESPIE FIELD	CA	SCal	
SEF	SEBRING RGNL	FL	SFl	
SEM	CRAIG FIELD	AL		
SER	FREEMAN MUNI	IN	Mid	
SFB	ORLANDO SANFORD INTL	FL	SFl	S
SFF	FELTS FIELD	WA		
SFM	SANFORD RGNL	ME	NE	
SFO	SAN FRANCISCO INTL	CA	NCAl	L
SFZ	NORTH CENTRAL STATE	RI	NE	
SGF	SPRINGFIELD-BRANSON NATIONAL	MO		S
SGH	SPRINGFIELD-BECKLEY MUNI	OH	Mid	
SGR	SUGAR LAND RGNL	TX	TX/Gulf	
SGU	ST GEORGE MUNI	UT		N
SGY	SKAGWAY	AK		
SHD	SHENANDOAH VALLEY RGNL	VA		
SHG	SHUNGNAK	AK		

Table A.1 (continued)

SHH	SHISHMAREF	AK		
SHN	SANDERSON FIELD	WA	Casc	
SHR	SHERIDAN COUNTY	WY		N
SHV	SHREVEPORT RGNL	LA		N
SHX	SHAGELUK	AK		
SIG	FERNANDO LUIS RIBAS DOMINICCI	PR		
SIK	SIKESTON MEMORIAL MUNI	MO		
SIT	SITKA ROCKY GUTIERREZ	AK		N
SJC	NORMAN Y. MINETA SAN JOSE INTL	CA	NCAl	M
SJN	ST JOHNS INDUSTRIAL AIR PARK	AZ		
SJT	SAN ANGELO RGNL/MATHIS FIELD	TX		N
SJU	LUIS MUNOZ MARIN INTL	PR		M
SKA	FAIRCHILD AFB	WA		
SKF	LACKLAND AFB (KELLY FLD ANNEX)	TX	TX	
SKW	SKWENTNA	AK		
SKY	GRIFFING SANDUSKY	OH	Mid	
SLB	STORM LAKE MUNI	IA		
SLC	SALT LAKE CITY INTL	UT		L
SLE	MCNARY FLD	OR	Casc	
SLJ	HAGLER AAF	MS		
SLK	ADIRONDACK RGNL	NY		
SLN	SALINA MUNI	KS		
SLO	SALEM-LECKRONE	IL		
SLQ	SLEETMUTE	AK		
SME	LAKE CUMBERLAND RGNL	KY		
SMF	SACRAMENTO INTL	CA	NCAl	M
SMK	ST MICHAEL	AK		
SMN	LEMHI COUNTY	ID		
SMO	SANTA MONICA MUNI	CA	SCal	
SMX	SANTA MARIA PUB/CAPT G ALLAN HANCOCK FLD	CA	SCal	N
SNA	JOHN WAYNE AIRPORT-ORANGE COUNTY	CA	SCal	M
SNL	SHAWNEE RGNL	OK		
SNP	ST PAUL ISLAND	AK		
SNS	SALINAS MUNI	CA	NCAl	
SNY	SIDNEY MUNI/LLOYD W. CARR FIELD	NE		
SOP	MOORE COUNTY	NC	Pied	
SOV	SELDOVIA	AK		
SOW	SHOW LOW RGNL	AZ		
SPA	SPARTANBURG DOWNTOWN MEMORIAL	SC	Pied	

Table A.1 (continued)

SPB	CHARLOTTE AMALIE HARBOR	VI		
SPI	ABRAHAM LINCOLN CAPITAL	IL	Mid	N
SPN	FRANCISCO C. ADA/SAIPAN INTL	CQ		S
SPS	SHEPPARD AFB/WICHITA FALLS MUNI	TX		N
SQI	WHITESIDE CO ARPT-JOS H BITTORF FLD	IL	Mid	
SRC	SEARCY MUNI	AR		
SRQ	SARASOTA/BRADENTON INTL	FL	SFl	S
SRV	STONY RIVER 2	AK		
SSC	SHAW AFB	SC		
SSI	MALCOLM MC KINNON	GA	SFl	
STC	ST CLOUD RGNL	MN	Mid	N
STE	STEVENS POINT MUNI	WI	Mid	
STF	GEORGE M BRYAN	MS		
STJ	ROSECRANS MEMORIAL	MO		
STL	LAMBERT-ST LOUIS INTL	MO	Mid	M
STP	ST PAUL DOWNTOWN HOLMAN FLD	MN	Mid	
STS	CHARLES M. SCHULZ - SONOMA COUNTY	CA	NCAl	
STT	CYRIL E KING	VI		S
STX	HENRY E ROHLSEN	VI		N
SUA	WITHAM FIELD	FL	SFl	
SUN	FRIEDMAN MEMORIAL	ID		N
SUS	SPIRIT OF ST LOUIS	MO	Mid	
SUU	TRAVIS AFB	CA	NCAl	
SUX	SIOUX GATEWAY/COL. BUD DAY FIELD	IA		N
SVA	SAVOONGA	AK		
SVC	GRANT COUNTY	NM		
SVH	STATESVILLE RGNL	NC	Pied	
SVN	HUNTER AAF	GA		
SVS	STEVENS VILLAGE	AK		
SVW	SPARREVOHN LRRS	AK		
SWD	SEWARD	AK		
SWF	STEWART INTL	NY	NE	N
SWO	STILLWATER RGNL	OK		
SWW	AVENGER FIELD	TX		
SXP	SHELDON POINT	AK		
SXQ	SOLDOTNA	AK		
SYA	EARECKSON AS	AK		
SYI	BOMAR FIELD-SHELBYVILLE MUNI	TN		
SYR	SYRACUSE HANCOCK INTL	NY		S
SZL	WHITEMAN AFB	MO		

Table A.1 (continued)

TAL	RALPH M CALHOUN MEMORIAL	AK		
TBN	WAYNESVILLE-ST. ROBERT RGNL	MO		
TBR	STATESBORO-BULLOCH COUNTY	GA		
TCL	TUSCALOOSA RGNL	AL	Pied	
TCM	MCCHORD AFB	WA	Casc	
TCT	TAKOTNA	AK		
TDF	PERSON COUNTY	NC	Pied	
TDW	TRADEWIND	TX		
TDZ	METCALF FIELD	OH	Mid	
TEB	TETERBORO	NJ	NE	N
TEX	TELLURIDE RGNL	CO		N
THA	TULLAHOMA RGNL ARPT/WM NORTHERN FIELD	TN		
THV	YORK	PA	NE	
TIK	TINKER AFB	OK		
TIW	TACOMA NARROWS	WA	Casc	
TIX	SPACE COAST RGNL	FL	SFl	
TKA	TALKEETNA	AK		
TKE	TENAKEE	AK		
TKI	COLLIN COUNTY RGNL AT MC KINNEY	TX	TX	
TKL	TAKU LODGE	AK		
TLH	TALLAHASSEE RGNL	FL		S
TLJ	TATALINA LRRS	AK		
TLR	MEFFORD FIELD	CA	NCAl	
TLT	TULUKSAK	AK		
TMA	HENRY TIFT MYERS	GA		
TMB	KENDALL-TAMIAMI EXECUTIVE	FL	SFl	
TNC	TIN CITY LRRS	AK		
TNP	TWENTYNINE PALMS	CA	SCal	
TNT	DADE-COLLIER TRAINING AND TRANSITION	FL	SFl	
TOA	ZAMPERINI FIELD	CA	SCal	
TOG	TOGIAK	AK		
TOL	TOLEDO EXPRESS	OH	Mid	N
TOR	TORRINGTON MUNI	WY		
TPA	TAMPA INTL	FL	SFl	L
TPH	TONOPAH	NV		
TPL	DRAUGHON-MILLER CENTRAL TEXAS RGNL	TX	TX	
TPO	PORT ALSWORTH	AK		
TRI	TRI-CITIES RGNL TN/VA	TN		N
TRM	JACQUELINE COCHRAN RGNL	CA	SCal	
TSG	TANACROSS	AK		

Table A.1 (continued)

TSP	TEHACHAPI MUNI	CA	SCal	
TTN	TRENTON MERCER	NJ	NE	N
TUL	TULSA INTL	OK		S
TUP	TUPELO RGNL	MS		N
TUS	TUCSON INTL	AZ	AZ	M
TVC	CHERRY CAPITAL	MI		N
TVF	THIEF RIVER FALLS RGNL	MN		
TVL	LAKE TAHOE	CA	NCAl	
TWF	JOSLIN FIELD - MAGIC VALLEY RGNL	ID		N
TXK	TEXARKANA RGNL-WEBB FIELD	AR		N
TYE	TYONEK	AK		
TYR	TYLER POUNDS RGNL	TX	TX	N
TYS	MC GHEE TYSON	TN		S
UAM	ANDERSEN AFB	GU		
UBS	COLUMBUS-LOWNDES COUNTY	MS		
UCY	EVERETT-STEWART RGNL	TN		
UDD	BERMUDA DUNES	CA	SCal	
UDG	DARLINGTON COUNTY JETPORT	SC		
UES	WAUKESHA COUNTY	WI	Mid	
UGB	UGASHIK BAY	AK		
UGN	WAUKEGAN RGNL	IL	Mid	
UIN	QUINCY RGNL-BALDWIN FIELD	IL		
UKI	UKIAH MUNI	CA		
ULS	ULYSSES	KS		
UMT	UMIAT	AK		
UNK	UNALAKLEET	AK		N
UOX	UNIVERSITY-OXFORD	MS		
UST	ST AUGUSTINE	FL	SFl	
UTO	INDIAN MOUNTAIN LRRS	AK		
UVA	GARNER FIELD	TX	TX	
UXL	SOUTHLAND FIELD	LA	Gulf	
VAD	MOODY AFB	GA		
VAK	CHEVAK	AK		
VBG	VANDENBERG AFB	CA	SCal	
VCB	NUT TREE	CA	NCAl	
VCT	VICTORIA RGNL	TX	Gulf	
VCV	SOUTHERN CALIFORNIA LOGISTICS	CA	SCal	
VDZ	VALDEZ PIONEER FIELD	AK		N
VEE	VENETIE	AK		
VEL	VERNAL RGNL	UT		

Table A.1 (continued)

VGT	NORTH LAS VEGAS	NV	SCal	N
VIH	ROLLA NATIONAL	MO		
VIS	VISALIA MUNI	CA	NCAl	
VLD	VALDOSTA RGNL	GA		N
VNC	VENICE MUNI	FL	SFl	
VNY	VAN NUYS	CA	SCal	
VOK	VOLK FIELD	WI		
VPC	CARTERSVILLE	GA	Pied	
VPS	EGLIN AFB	FL	Gulf	N
VPZ	PORTER COUNTY MUNI	IN	Mid	
VQS	ANTONIO RIVERA RODRIGUEZ	PR		N
VRB	VERO BEACH MUNI	FL	SFl	
VUJ	STANLY COUNTY	NC	Pied	
VYS	ILLINOIS VALLEY RGNL-WALTER A DUNCAN FIELD	IL	Mid	
WBB	STEBBINS	AK		
WBQ	BEAVER	AK		
WCR	CHANDALAR LAKE	AK		
WDG	ENID WOODRING RGNL	OK		
WDR	NORTHEAST GEORGIA REGIONAL	GA	Pied	
WFB	KETCHIKAN HARBOR	AK		
WJF	GENERAL WM J FOX AIRFIELD	CA	SCal	
WLK	SELAWIK	AK		
WMO	WHITE MOUNTAIN	AK		
WNA	NAPAKIAK	AK		
WRB	ROBINS AFB	GA		
WRG	WRANGELL	AK		N
WRI	MC GUIRE AFB	NJ	NE	
WRL	WORLAND MUNI	WY		
WSM	WISEMAN	AK		
WSN	SOUTH NAKNEK NR 2	AK		
WST	WESTERLY STATE	RI	NE	
WTK	NOATAK	AK		
WVI	WATSONVILLE MUNI	CA	NCAl	
WVL	WATERVILLE ROBERT LAFLEUR	ME		
WWD	CAPE MAY COUNTY	NJ	NE	
WWR	WEST WOODWARD	OK		
WWT	NEWTOK	AK		
WYS	YELLOWSTONE	MT		
XMR	CAPE CANAVERAL AFS SKID STRIP	FL	SFl	

Table A.1 (continued)

XNA	NORTHWEST ARKANSAS RGNL	AR		S
YAK	YAKUTAT	AK		N
YIP	WILLOW RUN	MI	Mid	
YKM	YAKIMA AIR TERMINAL/MCALLISTER FIELD	WA	Casc	N
YKN	CHAN GURNEY MUNI	SD		
YNG	YOUNGSTOWN-WARREN RGNL	OH	Mid	N
ZNC	NYAC	AK		
ZZV	ZANESVILLE MUNI	OH	Mid	

Table A.2: U.S. Airline Hubs

Airport	Passenger Hub	Focus City	Former Hub	Freight Hub
AFW				FX
ANC	AS			FX
ATL	DL, FL		TW*	
BDL				5X
BNA			AA	
BOS		AA, B6, FL		
BWI		FL, WN	US	
CAE				5X
CLE	CO		UA	
CLT	US			
CVG	DL			
DAL		WN		
DAY			US	
DCA		US		
DEN	UA	WN	CO	
DFW	AA		DL	5X
DTW	DL		NW*	
EWR	CO			FX
FLL		B6, FL		
GSO			CO	
HOU		WN		
IAD	UA			
IAH	CO			
IND		FL		FX
JFK	AA, B6, DL		TW*	
LAS		WN	US	
LAX	AA, UA	AS, WN	CO, DL, TW*	
LGA		AA, FL		
LGB		B6		
MCI			TW*, US	
MCO	FL	B6, WN	DL	
MDW		WN		
MEM	DL		NW*	FX
MIA	AA		UA	5X, FX
MKE	FL			
MSP	DL		NW*	

Table A.2 (continued)

OAK		WN		FX
ONT				5X
ORD	AA, UA		DL	
PDX	AS		DL	
PHL	US			5X
PHX	US	WN		
PIT			US	
RDU			AA	
RFD				5X
RSW		FL		
SDF				5X
SEA	AS		UA	
SFO	UA			
SJC			AA	
SLC	DL			
STL			AA, TW*	
TPA		FL		

Notes: Two letter FAA code used for airlines in table.
**Denotes airlines no longer operating*

APPENDIX B

MEGARGION FLOW TABLES

Table B.1: OD Passenger Flows

ORIGIN		DESTINATION: Megaregions AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Total Mega	Intramega	Intermega	Non-mega	International	Total
Megaregions	AZ	10.3	14.2	25.3	11.1	55.0	20.9	31.3	10.9	81.0	4.2	33.1	297.3	10.3	287.0	35.8	9.2	342.4
	Casc	14.0	23.0	18.8	5.2	45.0	14.3	58.4	8.9	56.6	1.9	17.0	263.2	23.0	240.2	67.6	21.9	352.7
	FR	25.3	18.9	20.7	16.1	69.6	37.1	30.9	15.2	52.7	11.0	47.2	344.6	20.7	323.9	67.8	9.7	422.0
	Gulf	11.3	5.3	16.4	70.7	51.4	39.3	11.3	51.2	29.5	31.8	110.8	428.8	70.7	358.2	49.2	44.9	522.9
	Mid	54.8	45.5	69.3	51.4	616.3	343.7	61.0	153.1	140.8	160.8	113.0	1809.8	616.3	1193.5	279.6	144.1	2233.5
	NE	20.8	14.1	37.4	39.5	344.3	255.9	46.4	174.2	92.4	249.8	86.9	1361.7	255.9	1105.8	150.8	328.0	1840.5
	NCal	30.7	58.7	30.0	11.3	60.8	47.7	20.1	13.7	196.5	5.1	38.4	513.2	20.1	493.0	54.3	67.0	634.4
	Pied	10.6	7.6	15.0	51.3	152.5	174.7	13.1	103.3	33.7	158.6	63.1	783.5	103.3	680.2	175.5	60.5	1019.5
	SCal	80.4	55.9	51.9	29.3	142.3	95.1	197.0	35.4	119.1	21.2	87.3	914.9	119.1	795.7	98.2	144.6	1157.7
	SFl	4.1	1.9	11.0	31.9	162.4	250.1	5.0	157.1	20.9	55.9	63.6	763.9	55.9	708.0	52.2	177.3	993.4
	TX	33.7	17.6	48.4	110.8	112.3	85.4	39.3	62.5	88.6	62.0	185.9	846.3	185.9	660.4	159.9	83.1	1089.3
Total Mega		296.0	262.6	344.1	428.7	1811.9	1364.1	513.7	785.4	911.8	762.4	846.3	8327.0			1190.9	1090.3	10608.2
Intramega		10.3	23.0	20.7	70.7	616.3	255.9	20.1	103.3	119.1	55.9	185.9						
Intermega		285.6	239.6	323.5	358.0	1195.7	1108.2	493.6	682.1	792.7	706.5	660.4						
Non-mega		35.5	68.3	67.8	49.2	280.7	150.2	54.1	175.0	98.3	52.8	160.4	1192.3			322.1	102.9	1617.2
International		8.9	22.4	9.9	44.8	146.7	331.6	67.2	60.9	142.7	178.3	83.2	1096.5			102.3	n/a	1198.8
Total		340.3	353.3	421.9	522.7	2239.4	1845.9	635.0	1021.3	1152.8	993.5	1089.9	10615.8			1615.3	1193.2	**13424.3**

Note: All flows in millions of trips.

Table B.2: Combined OD Passenger Flows

	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-mega	Inter-national
AZ	***10.3***	28.2	50.6	22.3	109.9	41.7	62.0	21.4	161.4	8.4	66.8	71.3	18.1
Casc	28.2	***23.0***	37.7	10.5	90.5	28.4	117.1	16.5	112.5	3.8	34.6	135.9	44.3
FR	50.6	37.7	***20.7***	32.5	138.9	74.6	60.9	30.2	104.6	22.0	95.6	135.6	19.5
Gulf	22.3	10.5	32.5	***70.7***	102.8	78.8	22.6	102.5	58.8	63.7	221.6	98.4	89.6
Mid	109.9	90.5	138.9	102.8	***616.3***	688.0	121.8	305.6	283.1	323.3	225.3	560.4	290.8
NE	41.7	28.4	74.6	78.8	688.0	***255.9***	94.1	348.9	187.5	499.9	172.3	301.0	659.6
NCal	62.0	117.1	60.9	22.6	121.8	94.1	***20.1***	26.8	393.5	10.1	77.7	108.4	134.2
Pied	21.4	16.5	30.2	102.5	305.6	348.9	26.8	***103.3***	69.1	315.7	125.6	350.5	121.3
SCal	161.4	112.5	104.6	58.8	283.1	187.5	393.5	69.1	***119.1***	42.1	175.8	196.5	287.3
SFl	8.4	3.8	22.0	63.7	323.3	499.9	10.1	315.7	42.1	***55.9***	125.6	104.9	355.7
TX	66.8	34.6	95.6	221.6	225.3	172.3	77.7	125.6	175.8	125.6	***185.9***	320.3	166.3
Non-mega	71.3	135.9	135.6	98.4	560.4	301.0	108.4	350.5	196.5	104.9	320.3	***322.1***	205.2
Inter-national	18.1	44.3	19.5	89.6	290.8	659.6	134.2	121.3	287.3	355.7	166.3	205.2	n/a

Note: All flows in millions of trips.

Table B.3: OD Freight Flows

ORIGIN		DESTINATION: Megaregion AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Total Mega	Intramega	Intermega	Non-mega	International	Total
Megaregion	AZ	5.4	5.7	16.7	2.8	72.7	8.9	24.0	4.4	36.9	1.6	12.9	192.1	5.4	186.7	66.7	8.3	267.1
Megaregion	Casc	6.2	29.9	16.4	4.2	164.0	22.4	60.8	26.8	50.9	4.7	12.5	398.8	29.9	368.9	187.2	210.5	796.6
Megaregion	FR	15.5	11.3	5.5	4.8	118.5	19.4	37.4	5.0	47.2	2.5	11.3	278.3	5.5	272.8	86.1	13.6	378.0
Megaregion	Gulf	3.6	2.5	7.3	21.7	94.7	36.9	6.7	16.2	23.5	13.9	47.9	274.7	21.7	253.0	91.3	276.5	642.5
Megaregion	Mid	99.6	176.7	156.3	110.8	1010.2	815.2	241.5	246.2	402.4	236.7	329.7	3825.2	1010.2	2815.1	1149.0	1736.6	6710.8
Megaregion	NE	10.4	12.4	28.2	27.7	722.0	153.1	132.7	103.4	190.3	102.2	83.2	1565.6	153.1	1412.5	559.3	2996.5	5121.4
Megaregion	NCal	28.7	83.3	42.7	7.4	248.6	154.5	31.6	19.7	123.9	10.8	52.7	803.8	31.6	772.2	317.6	596.0	1717.4
Megaregion	Pied	5.7	15.9	5.4	16.3	236.2	91.5	14.5	30.3	40.9	77.9	46.0	580.6	30.3	550.3	234.9	553.8	1369.3
Megaregion	SCal	48.9	60.8	44.1	23.7	445.8	284.7	124.3	53.0	38.9	42.5	119.6	1286.3	38.9	1247.5	562.2	1386.4	3234.9
Megaregion	SFl	1.8	4.3	5.6	19.2	193.2	145.5	15.4	86.5	49.1	39.6	63.9	624.1	39.6	584.5	277.8	2404.0	3306.0
Megaregion	TX	16.0	11.7	24.5	53.2	284.1	71.3	49.5	41.7	105.2	70.0	87.4	814.7	87.4	727.3	258.4	576.2	1649.3
Total Mega		241.8	414.5	352.5	291.8	3590.0	1803.3	738.5	633.1	1109.1	602.5	867.0	10644.3			3790.8	10758.3	25193.3
Intra-mega		5.4	29.9	5.5	21.7	1010.2	153.1	31.6	30.3	38.9	39.6	87.4						
Inter-mega		236.4	384.5	347.0	270.1	2579.9	1650.3	706.9	602.8	1070.3	562.9	779.6						
Non-mega		67.6	194.2	106.2	128.7	1254.9	564.5	282.6	237.4	580.0	310.8	292.6	4019.4			1534.2	1218.0	6771.6
Inter-national		8.7	159.1	15.1	214.5	2130.6	3862.7	740.1	665.1	1923.7	2753.9	588.0	13061.5			1844.0	n/a	14905.5
Total		318.0	767.8	473.9	635.0	6975.6	6230.6	1761.3	1535.6	3612.8	3667.2	1747.6	27725.2			7169.0	11976.3	46870.5

Note: All flows in ten million pounds of freight.

Table B.4: Combined OD Freight Flows

	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-mega	Inter-national
AZ	***5.4***	11.9	32.2	6.4	172.4	19.3	52.7	10.1	85.8	3.4	28.9	134.3	17.0
Casc	11.9	***29.9***	27.7	6.7	340.7	34.8	144.1	42.7	111.7	9.0	24.1	381.4	369.6
FR	32.2	27.7	***5.5***	12.0	274.8	47.5	80.0	10.3	91.3	8.1	35.8	192.3	28.7
Gulf	6.4	6.7	12.0	***21.7***	205.5	64.6	14.1	32.4	47.2	33.1	101.1	220.0	491.0
Mid	172.4	340.7	274.8	205.5	***1010.2***	1537.2	490.2	482.4	848.2	429.9	613.8	2403.9	3867.2
NE	19.3	34.8	47.5	64.6	1537.2	***153.1***	287.2	194.9	475.0	247.8	154.5	1123.8	6859.2
NCal	52.7	144.1	80.0	14.1	490.2	287.2	***31.6***	34.2	248.3	26.2	102.2	600.2	1336.1
Pied	10.1	42.7	10.3	32.4	482.4	194.9	34.2	***30.3***	93.9	164.4	87.7	472.3	1218.9
SCal	85.8	111.7	91.3	47.2	848.2	475.0	248.3	93.9	***38.9***	91.6	224.9	1142.2	3310.0
SFl	3.4	9.0	8.1	33.1	429.9	247.8	26.2	164.4	91.6	***39.6***	133.9	588.6	5157.9
TX	28.9	24.1	35.8	101.1	613.8	154.5	102.2	87.7	224.9	133.9	***87.4***	551.0	1164.2
Non-mega	134.3	381.4	192.3	220.0	2403.9	1123.8	600.2	472.3	1142.2	588.6	551.0	***1534.2***	3062.0
Inter-national	17.0	369.6	28.7	491.0	3867.2	6859.2	1336.1	1218.9	3310.0	5157.9	1164.2	3062.0	n/a

Note: All flows in ten million pounds of freight.

Table B.5: Combined OD Passenger Flows by Area

	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
AZ	***211.7***	293.4	479.1	209.6	432.8	377.4	639.3	197.7	1458.3	95.6	499.8	31.1
Casc	293.4	***485.0***	362.2	100.1	358.5	260.7	1226.2	154.2	1030.0	44.7	261.6	59.3
FR	479.1	362.2	***364.2***	283.5	530.8	629.9	580.4	259.5	881.9	229.9	675.5	58.9
Gulf	209.6	100.1	283.5	***1221.9***	391.1	659.4	213.2	873.0	490.9	659.6	1554.3	42.7
Mid	432.8	358.5	530.8	391.1	***3005.7***	2579.8	481.0	1154.8	1060.8	1326.0	777.5	228.7
NE	377.4	260.7	629.9	659.4	2579.8	***4151.7***	857.0	2878.3	1517.9	4977.8	1177.0	130.5
NCal	639.3	1226.2	580.4	213.2	481.0	857.0	***417.9***	248.9	3576.1	116.1	584.4	47.2
Pied	197.7	154.2	259.5	873.0	1154.8	2878.3	248.9	***1733.7***	569.3	3209.1	870.0	152.1
SCal	1458.3	1030.0	881.9	490.9	1060.8	1517.9	3576.1	569.3	***1925.5***	418.7	1199.2	85.2
SFl	95.6	44.7	229.9	659.6	1326.0	4977.8	116.1	3209.1	418.7	***1441.1***	1016.2	45.9
TX	499.8	261.6	675.5	1554.3	777.5	1177.0	584.4	870.0	1199.2	1016.2	***2192.7***	137.4
Non-mega	31.1	59.3	58.9	42.7	228.7	130.5	47.2	152.1	85.2	45.9	137.4	***143.4***

Note: All flows in trips per square mile of both megaregions (or non-megaregion areas).

Table B.6: Combined OD Passenger Flows by Population

	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
AZ	***2.28***	2.36	5.46	1.37	1.88	0.77	3.59	1.11	6.11	0.44	3.23	0.91
Casc	2.36	***3.10***	3.11	0.55	1.48	0.50	5.82	0.74	3.84	0.17	1.47	1.68
FR	5.46	3.11	***4.36***	1.97	2.37	1.37	3.49	1.54	3.93	1.13	4.58	1.73
Gulf	1.37	0.55	1.97	***6.02***	1.57	1.28	0.92	3.85	1.75	2.41	7.95	1.15
Mid	1.88	1.48	2.37	1.57	***11.46***	6.66	1.83	4.45	3.74	4.72	3.22	4.40
NE	0.77	0.50	1.37	1.28	6.66	***5.16***	1.51	5.42	2.62	7.78	2.62	2.45
NCal	3.59	5.82	3.49	0.92	1.83	1.51	***1.58***	0.97	11.38	0.37	2.69	1.26
Pied	1.11	0.74	1.54	3.85	4.45	5.42	0.97	***6.95***	1.88	10.69	4.05	3.97
SCal	6.11	3.84	3.93	1.75	3.74	2.62	11.38	1.88	***5.45***	1.15	4.63	2.06
SFl	0.44	0.17	1.13	2.41	4.72	7.78	0.37	10.69	1.15	***3.81***	4.07	1.19
TX	3.23	1.47	4.58	7.95	3.22	2.62	2.69	4.05	4.63	4.07	***11.52***	3.57
Non-mega	0.91	1.68	1.73	1.15	4.40	2.45	1.26	3.97	2.06	1.19	3.57	***4.38***

Note: All flows in trips per capita of both megaregions (or non-megaregion areas).

Table B.7: Combined OD Passenger Flows by Economic Productivity

	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
AZ	***54.1***	53.4	120.4	31.3	48.5	15.0	76.2	31.7	131.4	10.5	66.2	20.8
Casc	53.4	***68.1***	66.6	12.2	37.5	9.7	122.0	20.0	81.9	4.1	29.9	38.0
FR	120.4	66.6	***90.2***	43.1	60.4	26.4	71.5	42.2	82.6	26.2	91.3	39.1
Gulf	31.3	12.2	43.1	***134.9***	39.6	25.3	19.7	101.5	37.6	56.3	165.2	26.2
Mid	48.5	37.5	60.4	39.6	***297.3***	147.5	45.2	119.4	91.0	120.6	77.9	105.6
NE	15.0	9.7	26.4	25.3	147.5	***98.8***	29.3	113.4	51.7	156.3	50.5	51.7
NCal	76.2	122.0	71.5	19.7	45.2	29.3	***32.3***	24.2	237.1	8.2	53.9	28.1
Pied	31.7	20.0	42.2	101.5	119.4	113.4	24.2	***212.6***	45.4	288.5	96.3	94.2
SCal	131.4	81.9	82.6	37.6	91.0	51.7	237.1	45.4	***114.9***	25.6	94.8	46.0
SFl	10.5	4.1	26.2	56.3	120.6	156.3	8.2	288.5	25.6	***91.9***	88.0	27.3
TX	66.2	29.9	91.3	165.2	77.9	50.5	53.9	96.3	94.8	88.0	***227.2***	79.0
Non-mega	20.8	38.0	39.1	26.2	105.6	51.7	28.1	94.2	46.0	27.3	79.0	***99.6***

Note: All flows in trips per $ trillion GMP of both megaregions (or non-megaregion areas).

Table B.8: Combined OD Freight Flows by Area

	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
AZ	***1105.6***	1237.8	3052.5	601.6	6790.8	1748.3	5431.8	933.1	7748.8	392.0	2162.0	585.4
Casc	1237.8	***6321.9***	2657.2	639.6	13498.3	3194.3	15087.6	3996.9	10228.2	1046.3	1827.2	1663.7
FR	3052.5	2657.2	***972.0***	1050.4	10496.2	4017.1	7629.0	887.9	7699.4	848.4	2531.1	835.3
Gulf	601.6	639.6	1050.4	***3747.8***	7816.7	5404.8	1332.2	2761.3	3940.0	3423.9	7091.3	955.3
Mid	6790.8	13498.3	10496.2	7816.7	***49628.6***	57644.9	19358.3	18231.0	31779.4	17633.6	21179.6	9810.2
NE	1748.3	3194.3	4017.1	5404.8	57644.9	***24837.9***	26153.4	16081.3	38460.5	24674.0	10553.1	4871.5
NCal	5431.8	15087.6	7629.0	1332.2	19358.3	26153.4	***6570.1***	3170.5	22563.1	3007.5	7686.7	2617.0
Pied	933.1	3996.9	887.9	2761.3	18231.0	16081.3	3170.5	***5089.2***	7733.2	16710.1	6074.5	2049.1
SCal	7748.8	10228.2	7699.4	3940.0	31779.4	38460.5	22563.1	7733.2	***6280.8***	9097.8	15334.9	4950.6
SFl	392.0	1046.3	848.4	3423.9	17633.6	24674.0	3007.5	16710.1	9097.8	***10223.1***	10839.9	2576.8
TX	2162.0	1827.2	2531.1	7091.3	21179.6	10553.1	7686.7	6074.5	15334.9	10839.9	***10307.4***	2364.7
Non-mega	585.4	1663.7	835.3	955.3	9810.2	4871.5	2617.0	2049.1	4950.6	2576.8	2364.7	***6832.9***

Note: All flows in pounds of freight per square mile of both megaregions (or non-megaregion areas).

Table B.9: Combined OD Freight Flows by Population

	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
AZ	***11.9***	10.0	34.8	3.9	29.6	3.6	30.5	5.2	32.5	1.8	14.0	17.2
Casc	10.0	***40.4***	22.8	3.5	55.7	6.1	71.6	19.2	38.2	4.1	10.3	47.1
FR	34.8	22.8	***11.6***	7.3	47.0	8.8	45.8	5.3	34.3	4.2	17.2	24.6
Gulf	3.9	3.5	7.3	***18.5***	31.4	10.5	5.8	12.2	14.0	12.5	36.3	25.8
Mid	29.6	55.7	47.0	31.4	***187.9***	148.8	73.7	70.3	112.2	62.8	87.8	188.9
NE	3.6	6.1	8.8	10.5	148.8	***30.9***	46.1	30.3	66.5	38.6	23.5	91.3
NCal	30.5	71.6	45.8	5.8	73.7	46.1	***24.9***	12.4	71.8	9.5	35.4	69.6
Pied	5.2	19.2	5.3	12.2	70.3	30.3	12.4	***20.4***	25.6	55.6	28.3	53.5
SCal	32.5	38.2	34.3	14.0	112.2	66.5	71.8	25.6	***17.8***	25.1	59.2	119.8
SFl	1.8	4.1	4.2	12.5	62.8	38.6	9.5	55.6	25.1	***27.0***	43.5	66.7
TX	14.0	10.3	17.2	36.3	87.8	23.5	35.4	28.3	59.2	43.5	***54.2***	61.5
Non-mega	17.2	47.1	24.6	25.8	188.9	91.3	69.6	53.5	119.8	66.7	61.5	***208.7***

Note: All flows in pounds of freight per capita of both megaregions (or non-megaregion areas).

Table B.10: Combined OD Freight Flows by Economic Productivity

	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
AZ	***282.5***	225.4	767.0	89.7	761.4	69.4	647.1	149.4	698.4	43.0	286.2	392.0
Casc	225.4	***888.1***	488.6	78.1	1413.5	118.9	1501.1	519.3	812.9	95.4	209.0	1067.9
FR	767.0	488.6	***240.8***	159.8	1193.5	168.6	939.3	144.4	721.3	96.8	342.1	555.1
Gulf	89.7	78.1	159.8	***413.6***	791.2	207.3	123.1	321.0	302.1	292.2	753.5	585.3
Mid	761.4	1413.5	1193.5	791.2	***4873.0***	3295.9	1818.1	1885.2	2727.3	1603.6	2123.1	4528.8
NE	69.4	118.9	168.6	207.3	3295.9	***590.8***	893.5	633.5	1309.2	774.5	453.2	1929.0
Ncal	647.1	1501.1	939.3	123.1	1818.1	893.5	***508.0***	308.1	1495.6	212.4	709.1	1555.8
Pied	149.4	519.3	144.4	321.0	1885.2	633.5	308.1	***623.9***	616.7	1502.5	672.4	1269.3
Scal	698.4	812.9	721.3	302.1	2727.3	1309.2	1495.6	616.7	***374.7***	556.6	1212.2	2673.7
SFl	43.0	95.4	96.8	292.2	1603.6	774.5	212.4	1502.5	556.6	***652.1***	939.2	1531.6
TX	286.2	209.0	342.1	753.5	2123.1	453.2	709.1	672.4	1212.2	939.2	***1068.1***	1359.5
Non-mega	392.0	1067.9	555.1	585.3	4528.8	1929.0	1555.8	1269.3	2673.7	1531.6	1359.5	***4742.6***

Note: All flows in pounds of freight per $ trillion GMP of both megaregions (or non-megaregion areas).

Table B.11: Passenger Growth Over Time

FLOW TYPE	YEAR																		
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AZ	6	6	6	6	6	7	7	6	6	6	6	5	4	4	5	5	5	4	4
Casc	9	11	11	12	12	12	13	13	12	12	12	10	11	12	12	13	13	15	15
FR	8	9	11	10	10	12	14	13	12	12	11	9	9	10	12	11	10	11	13
Gulf	27	25	27	28	29	38	39	41	41	42	42	41	39	39	40	40	44	44	41
Mid	264	260	294	297	320	332	336	348	360	362	373	338	328	348	350	336	319	311	287
NE	121	106	106	106	110	117	117	125	136	148	152	130	122	140	158	169	169	169	158
NCal	12	13	13	11	8	9	12	12	12	11	9	8	8	12	12	11	11	10	8
Pied	45	38	41	44	53	54	58	60	61	61	62	55	53	55	55	58	57	61	62
SCal	46	47	47	49	57	60	63	59	60	67	73	65	61	69	75	78	76	75	65
SFl	26	27	27	23	28	20	21	21	31	30	32	30	29	30	32	36	38	40	38
TX	91	86	92	97	103	107	107	107	108	107	109	99	88	87	94	94	97	96	91
Intra-mega	654	627	675	683	735	766	787	803	841	856	881	790	751	806	846	851	839	836	783
Inter-mega	2612	2556	2677	2761	3031	3159	3388	3528	3625	3796	3991	3772	3726	3871	4207	4379	4415	4561	4404
Non-mega	1045	1026	1076	1102	1187	1232	1297	1322	1332	1368	1434	1344	1335	1447	1572	1680	1681	1736	1669
Inter-national	736	722	797	844	884	948	1017	1092	1159	1245	1350	1233	1189	1197	1357	1445	1502	1570	1582
Internal Non-mega	163	158	161	160	168	166	169	168	163	162	166	150	160	177	176	188	188	198	176
TOTAL	**5210**	**5090**	**5385**	**5550**	**6006**	**6271**	**6658**	**6914**	**7120**	**7428**	**7822**	**7288**	**7161**	**7499**	**8158**	**8543**	**8626**	**8901**	**8613**

Note: All flows in one hundred thousand trips.

Table B.12: Freight Growth Over Time

FLOW TYPE	YEAR																		
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
AZ	1	2	2	1	1	2	2	2	2	2	1	1	3	5	2	1	2	8	13
Casc	7	7	7	9	9	8	8	6	6	5	6	7	19	38	42	44	30	24	18
FR	4	4	4	4	4	3	3	4	4	4	3	2	2	2	2	2	2	1	0
Gulf	8	10	10	11	10	9	11	10	11	11	10	14	15	15	12	10	14	16	9
Mid	110	115	111	109	104	87	79	75	71	61	99	527	743	1382	1431	1301	1292	1261	1145
NE	30	22	20	13	16	14	14	14	14	14	14	81	121	205	197	195	194	193	160
NCal	1	1	1	1	1	1	1	1	1	1	1	12	25	48	46	47	46	44	37
Pied	33	22	21	22	19	16	16	16	15	14	12	11	13	16	15	13	11	11	8
SCal	13	13	13	13	14	13	14	15	12	14	14	13	20	38	33	34	38	38	28
SFl	8	8	11	13	11	6	3	3	3	4	11	30	41	49	36	44	39	39	37
TX	33	33	34	31	28	25	20	18	19	17	15	40	50	72	78	94	98	92	77
Intra-mega	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.7	1.1	1.9	1.9	1.8	1.8	1.7	1.5
Inter-mega	2.4	2.4	2.4	2.4	2.4	2.2	2.1	2.1	2.0	2.2	2.0	4.7	6.0	9.6	10.1	10.0	9.8	9.4	8.0
Non-mega	1.5	1.7	1.7	1.7	1.8	1.9	2.1	2.2	2.1	2.3	2.5	4.0	6.5	12.1	13.0	13.3	13.2	13.3	11.9
Inter-national	7.3	7.3	7.9	8.8	10.0	10.8	11.6	12.8	12.9	13.2	14.2	13.0	13.6	14.0	15.4	15.7	16.5	17.0	16.1
Internal Non-mega	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.3	0.7	2.0	2.1	2.1	2.1	2.2	2.0
TOTAL	**11.6**	**11.7**	**12.3**	**13.3**	**14.6**	**15.2**	**16.1**	**17.4**	**17.3**	**17.9**	**19.0**	**22.8**	**27.9**	**39.6**	**42.6**	**42.8**	**43.4**	**43.6**	**39.6**

Note: All megaregion specific flows in millions of pounds of freight. All aggregated flows in billions of pounds of freight.

APPENDIX C

MEGAREGION SPECIFIC FLOWS

Table C.1: Arizona Sun Corridor Passenger Flows

	Passengers (trips)	**Production (trips)**	**Attraction (trips)**
Southern California	161391734	81031151	80360583
Midwest	109859592	55037957	54821635
Non-Mega	71321157	35844497	35476660
Texas Triangle	66767018	33064864	33702154
Northern California	61997280	31299573	30697707
Front Range	50562215	25306021	25256194
Northeast	41678001	20873511	20804490
Cascadia	28208508	14199970	14008538
Gulf Coast	22347242	11077954	11269288
Piedmont	21431408	10855870	10575538
International	18073361	9184670	8888691
Intramega	10334221		
Southern Florida	8375153	4248755	4126398

Standardized by:	Intra-mega	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	**211.7**	293.4	479.1	209.6	432.8	377.4	639.3	197.7	1458.3	95.6	499.8	31.1
Population	**2.28**	2.36	5.46	1.37	1.88	0.77	3.59	1.11	6.11	0.44	3.23	0.91
Economic Production	**54.1**	53.4	120.4	31.3	48.5	15.0	76.2	31.7	131.4	10.5	66.2	20.8

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of the Arizona Sun Corridor and the respective megaregion (or non-megaregion areas).

Table C.2: Arizona Sun Corridor Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
Midwest	1723772482	727301090	996471392	31.2%
Non-Mega	1343019943	667167992	675851951	1.3%
Southern California	857589544	368500650	489088894	28.1%
Northern California	526778396	240241425	286536971	17.6%
Front Range	322158884	166935517	155223367	-7.3%
Texas Triangle	288790999	129035494	159755505	21.3%
Northeast	193087915	89105984	103981931	15.4%
International	169834839	83248941	86585898	3.9%
Cascadia	119011010	57111680	61899330	8.0%
Piedmont	101141844	44232910	56908934	25.1%
Gulf Coast	64151334	28216629	35934705	24.1%
Intramega	53962549			
Southern Florida	34337377	16087727	18249650	12.6%

Standardized by:	Intra-mega	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	**1105.6**	1237.8	3052.5	601.6	6790.8	1748.3	5431.8	933.1	7748.8	392.0	2162.0	585.4
Population	**11.9**	10.0	34.8	3.9	29.6	3.6	30.5	5.2	32.5	1.8	14.0	17.2
Economic Production	**282.5**	225.4	767.0	89.7	761.4	69.4	647.1	149.4	698.4	43.0	286.2	392.0

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of the Arizona Sun Corridor and the respective megaregion (or non-megaregion areas).

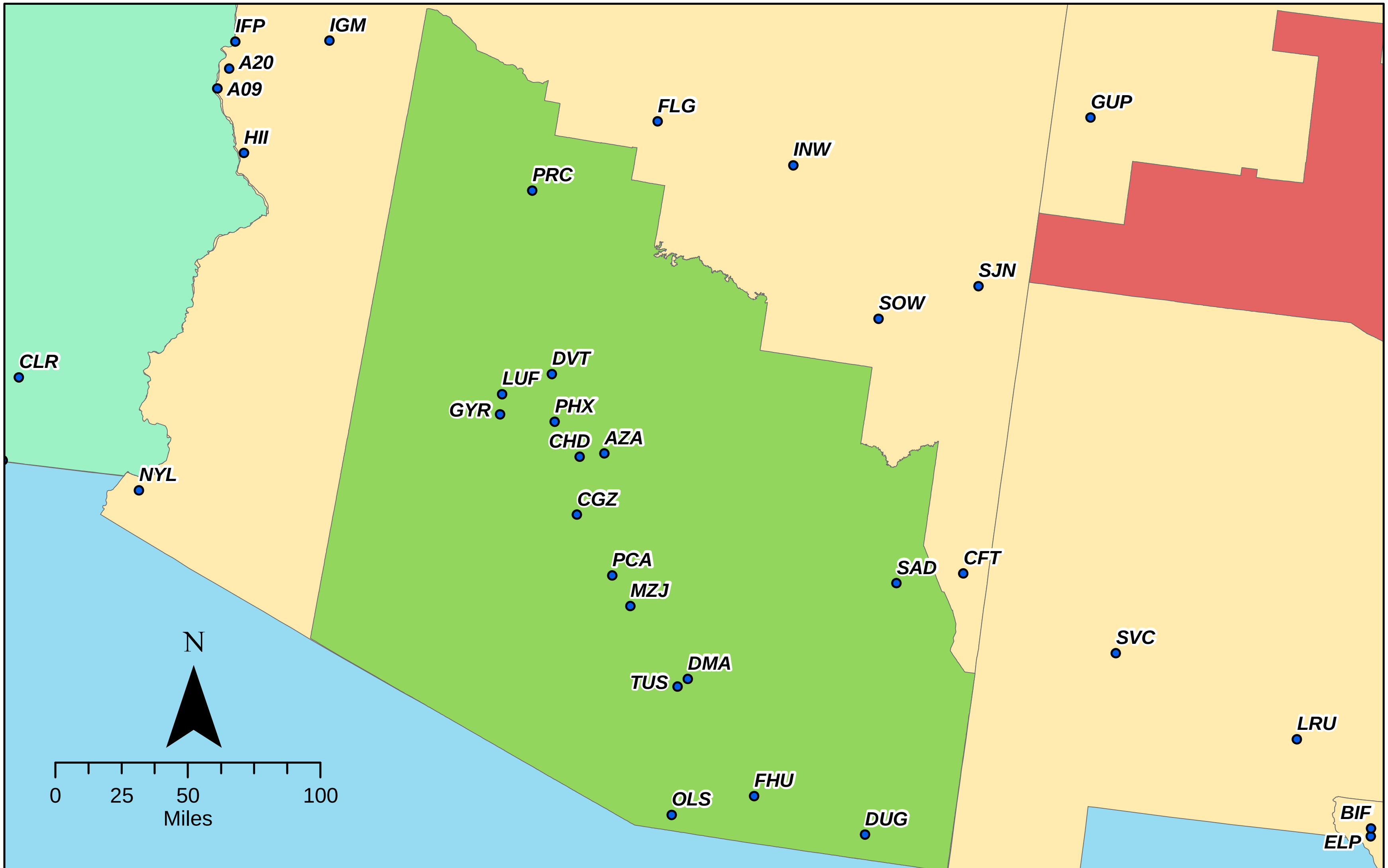

Figure C.1: Arizona Sun Corridor Megaregion Airports (T-100 Dataset)

Table C.3: Cascadia Passenger Flows

	Passengers (trips)	**Production (trips)**	**Attraction (trips)**
Non-Mega	135909270	67586746	68322524
Northern California	117113669	58377242	58736427
Southern California	112478567	56626552	55852015
Midwest	90488183	44989514	45498669
International	44265462	21912038	22353424
Front Range	37694228	18795881	18898347
Texas Triangle	34561284	16960963	17600321
Northeast	28409765	14332579	14077186
Arizona Sun Corridor	28208508	14008538	14199970
Intramega	22959605		
Piedmont	16486649	8923508	7563141
Gulf Coast	10528625	5245880	5282745
Southern Florida	3846691	1939101	1907590

Standardized by:	AZ	Intra-mega	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	293.4	**485.0**	362.2	100.1	358.5	260.7	1226.2	154.2	1030.0	44.7	261.6	59.3
Population	2.36	**3.10**	3.11	0.55	1.48	0.50	5.82	0.74	3.84	0.17	1.47	1.68
Economic Production	53.4	**68.1**	66.6	12.2	37.5	9.7	122.0	20.0	81.9	4.1	29.9	38.0

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of Cascadia and the respective megaregion (or non-megaregion areas).

Table C.4: Cascadia Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
Non-Mega	3814413745	1871940405	1942473340	3.7%
International	3696275053	2105251269	1591023784	-27.8%
Midwest	3406614833	1639872638	1766742195	7.4%
Northern California	1441057256	608393829	832663427	31.1%
Southern California	1116982985	509244587	607738398	17.6%
Piedmont	427362159	268167352	159194807	-51.0%
Northeast	348100707	223943679	124157028	-57.3%
Intramega	299287420			
Front Range	276542125	163909684	112632441	-37.1%
Texas Triangle	241388269	124616342	116771927	-6.5%
Arizona Sun Corridor	119011010	61899330	57111680	-8.0%
Southern Florida	90111295	46981480	43129815	-8.5%
Gulf Coast	67270182	42109293	25160889	-50.4%

Standardized by:	AZ	Intra-mega	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	1237.8	**6321.9**	2657.2	639.6	13498.3	3194.3	15087.6	3996.9	10228.2	1046.3	1827.2	1663.7
Population	10.0	**40.4**	22.8	3.5	55.7	6.1	71.6	19.2	38.2	4.1	10.3	47.1
Economic Production	225.4	**888.1**	488.6	78.1	1413.5	118.9	1501.1	519.3	812.9	95.4	209.0	1067.9

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of Cascadia and the respective megaregion (or non-megaregion areas).

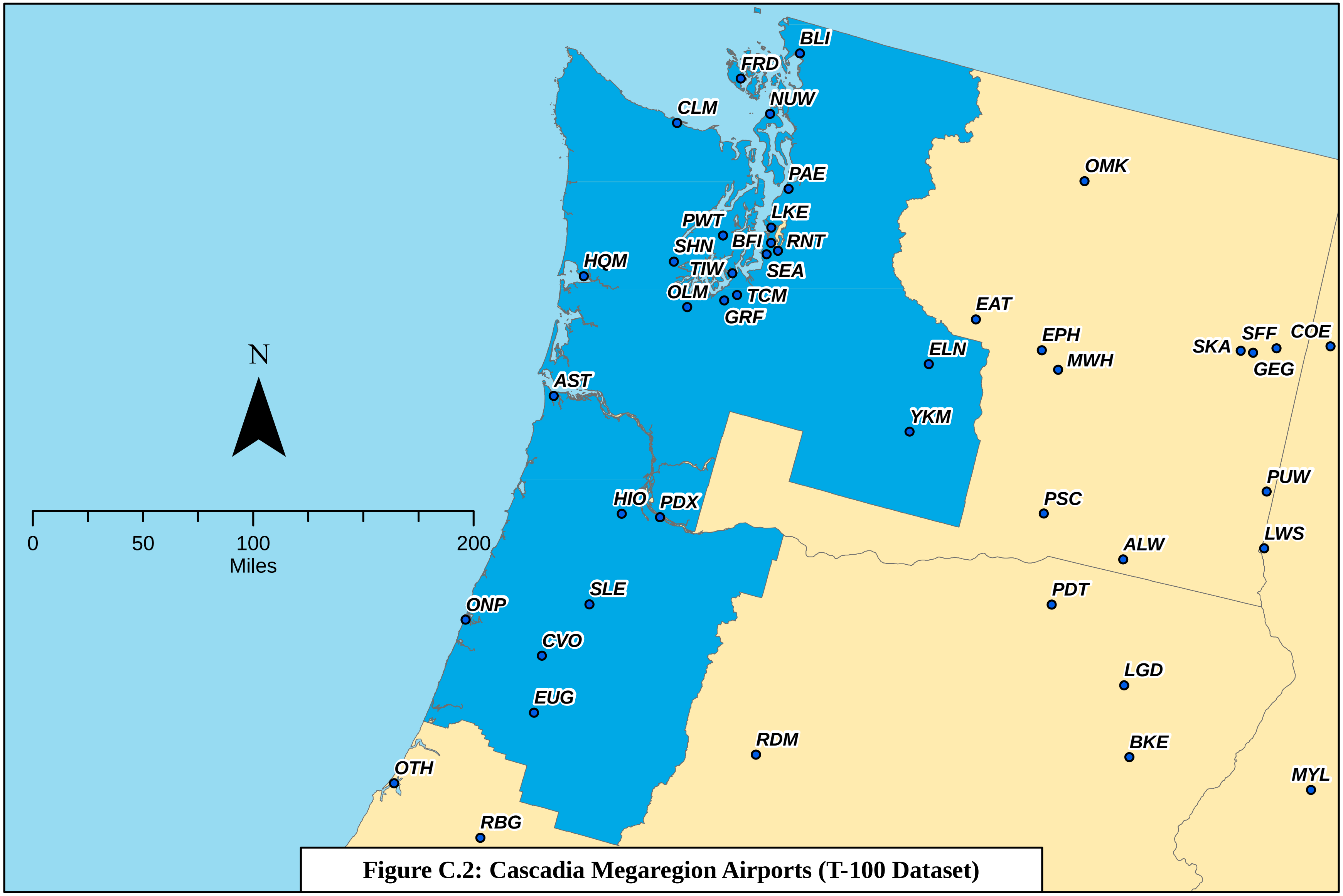

Figure C.2: Cascadia Megaregion Airports (T-100 Dataset)

Table C.5: Front Range Passenger Flows

	Passengers (trips)	Production (trips)	Attraction (trips)
Midwest	138938180	69644262	69293918
Non-Mega	135583415	67752022	67831393
Southern California	104584778	52707030	51877748
Texas Triangle	95577679	47217842	48359837
Northeast	74552581	37117030	37435551
Northern California	60880788	30865517	30015271
Arizona Sun Corridor	50562215	25256194	25306021
Cascadia	37694228	18898347	18795881
Gulf Coast	32479436	16078700	16400736
Piedmont	30187997	15158456	15029541
Southern Florida	21959526	10997777	10961749
Intramega	20658751		
International	19542018	9657436	9884582

Standardized by:	AZ	Casc	Intra-mega	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	479.1	362.2	**364.2**	283.5	530.8	629.9	580.4	259.5	881.9	229.9	675.5	58.9
Population	5.46	3.11	**4.36**	1.97	2.37	1.37	3.49	1.54	3.93	1.13	4.58	1.73
Economic Production	120.4	66.6	**90.2**	43.1	60.4	26.4	71.5	42.2	82.6	26.2	91.3	39.1

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of the Front Range and the respective megaregion (or non-megaregion areas).

Table C.6: Front Range Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
Midwest	2747508770	1184884198	1562624572	27.5%
Non-Mega	1922919768	861115941	1061803827	20.9%
Southern California	913121082	471866453	441254629	-6.7%
Northern California	800309212	373718738	426590474	13.2%
Northeast	475487356	193670569	281816787	37.1%
Texas Triangle	358154639	113494795	244659844	73.2%
Arizona Sun Corridor	322158884	155223367	166935517	7.3%
International	287133073	135708835	151424238	10.9%
Cascadia	276542125	112632441	163909684	37.1%
Gulf Coast	120341397	47626974	72714423	41.7%
Piedmont	103272180	49517610	53754570	8.2%
Southern Florida	81033994	25088024	55945970	76.2%
Intramega	55143624			

Standardized by:	AZ	Casc	Intra-mega	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	3052.5	2657.2	**972.0**	1050.4	10496.2	4017.1	7629.0	887.9	7699.4	848.4	2531.1	835.3
Population	34.8	22.8	**11.6**	7.3	47.0	8.8	45.8	5.3	34.3	4.2	17.2	24.6
Economic Production	767.0	*488.6*	**240.8**	159.8	1193.5	168.6	939.3	144.4	721.3	96.8	342.1	555.1

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of the Front Range and the respective megaregion (or non-megaregion areas).

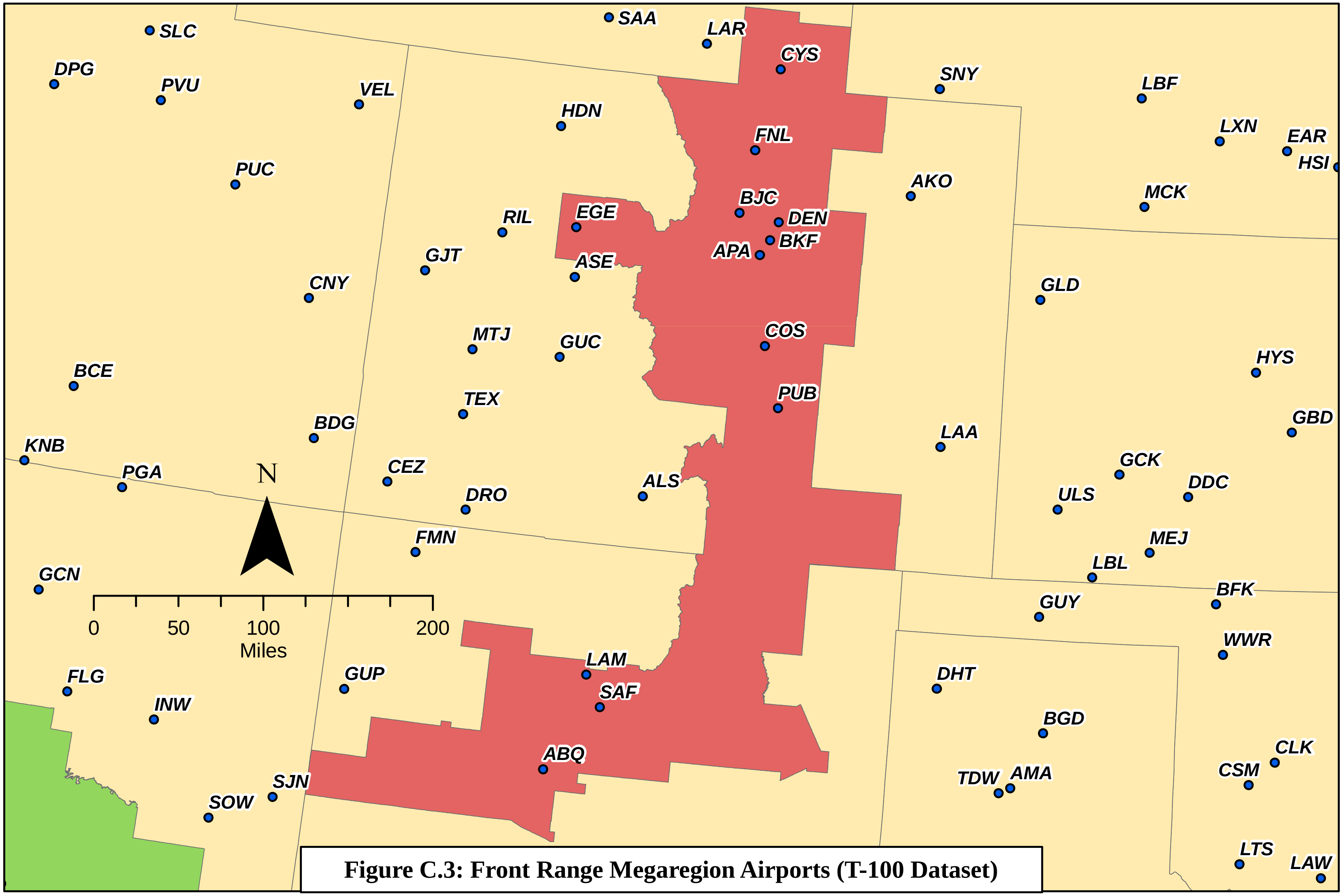

Figure C.3: Front Range Megaregion Airports (T-100 Dataset)

Table C.7: Gulf Coast Passenger Flows

	Passengers (trips)	Production (trips)	Attraction (trips)
Texas Triangle	221642113	110803444	110838669
Midwest	102814175	51370867	51443308
Piedmont	102506070	51198465	51307605
Non-Mega	98445200	49241005	49204195
International	89645158	44850680	44794478
Northeast	78780409	39280847	39499562
Intramega	70666029		
Southern Florida	63732366	31826586	31905780
Southern California	58763184	29479198	29283986
Front Range	32479436	16400736	16078700
Northern California	22598825	11269064	11329761
Arizona Sun Corridor	22347242	11269288	11077954
Cascadia	10528625	5282745	5245880

Standardized by:	AZ	Casc	FR	Inter-mega	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	209.6	100.1	283.5	**1221.9**	391.1	659.4	213.2	873.0	490.9	659.6	1554.3	42.7
Population	1.37	0.55	1.97	**6.02**	1.57	1.28	0.92	3.85	1.75	2.41	7.95	1.15
Economic Production	31.3	12.2	43.1	**134.9**	39.6	25.3	19.7	101.5	37.6	56.3	165.2	26.2

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of the Gulf Coast and the respective megaregion (or non-megaregion areas).

Table C.8: Gulf Coast Freight Flows

	Freight (lbs)	**Production (lbs)**	**Attraction (lbs)**	**% Difference**
International	4910028163	2764696311	2145331852	-25.2%
Non-Mega	2200242966	913322214	1286920752	34.0%
Midwest	2054748036	946536682	1108211354	15.7%
Texas Triangle	1011230703	478816337	532414366	10.6%
Northeast	645703356	368779234	276924122	-28.5%
Southern California	471611860	234523566	237088294	1.1%
Southern Florida	330805826	139101472	191704354	31.8%
Piedmont	324222975	161651094	162571881	0.6%
Intramega	216749252			
Northern California	141223840	66934789	74289051	10.4%
Front Range	120341397	72714423	47626974	-41.7%
Cascadia	67270182	25160889	42109293	50.4%
Arizona Sun Corridor	64151334	35934705	28216629	-24.1%

Standardized by:	AZ	Casc	FR	Intra-mega	Mid	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	601.6	639.6	1050.4	**3747.8**	7816.7	5404.8	1332.2	2761.3	3940.0	3423.9	7091.3	955.3
Population	3.9	3.5	7.3	**18.5**	31.4	10.5	5.8	12.2	14.0	12.5	36.3	25.8
Economic Production	89.7	78.1	*159.8*	**413.6**	791.2	207.3	123.1	321.0	302.1	292.2	753.5	585.3

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of the Gulf Coast and the respective megaregion (or non-megaregion areas).

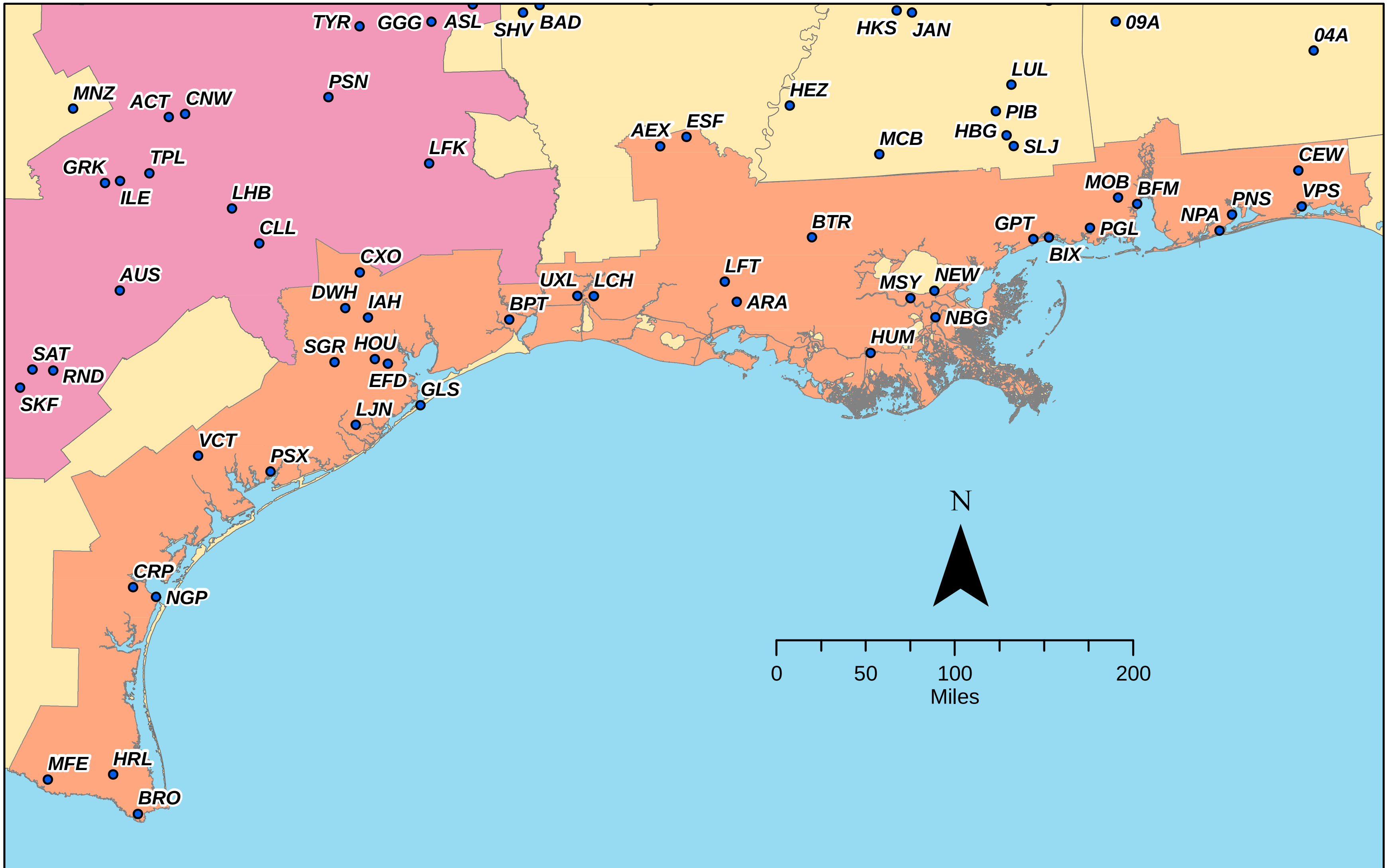

Figure C.4: Gulf Coast Megaregion Airports (T-100 Dataset)

Table C.9: Midwest Passenger Flows

	Passengers (trips)	Production (trips)	Attraction (trips)
Northeast	687953180	343659669	344293511
Intramega	616259829		
Non-Mega	560354045	279615079	280738966
Southern Florida	323291470	160849872	162441598
Piedmont	305569547	153054202	152515345
International	290824582	144129881	146694701
Southern California	283132159	140822559	142309600
Texas Triangle	225308290	113044240	112264050
Front Range	138938180	69293918	69644262
Northern California	121800001	61004525	60795476
Arizona Sun Corridor	109859592	54821635	55037957
Gulf Coast	102814175	51443308	51370867
Cascadia	90488183	45498669	44989514

Standardized by:	AZ	Casc	FR	Gulf	Intra-mega	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	432.8	358.5	530.8	391.1	**3005.7**	2579.8	481.0	1154.8	1060.8	1326.0	777.5	228.7
Population	1.88	1.48	2.37	1.57	**11.46**	6.66	1.83	4.45	3.74	4.72	3.22	4.40
Economic Production	48.5	37.5	60.4	39.6	**297.3**	147.5	45.2	119.4	91.0	120.6	77.9	105.6

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of the Midwest and the respective megaregion (or non-megaregion areas).

Table C.10: Midwest Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
International	38671772113	17365580273	21306191840	20.4%
Non-Mega	24039018436	11490034949	12548983487	8.8%
Northeast	15371924580	8151749308	7220175272	-12.1%
Intramega	10101634112			
Southern California	8481821935	4023897228	4457924707	10.2%
Texas Triangle	6137856670	3296594102	2841262568	-14.8%
Northern California	4901606073	2415376956	2486229117	2.9%
Piedmont	4824185391	2461777488	2362407903	-4.1%
Southern Florida	4299350997	2367242505	1932108492	-20.2%
Cascadia	3406614833	1766742195	1639872638	-7.4%
Front Range	2747508770	1562624572	1184884198	-27.5%
Gulf Coast	2054748036	1108211354	946536682	-15.7%
Arizona Sun Corridor	1723772482	996471392	727301090	-31.2%

Stand. by:	AZ	Casc	FR	Gulf	Intra-mega	NE	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	6790.8	13498.3	10496.2	7816.7	**49268.6**	57644.9	19358.3	18231.0	31779.4	17633.6	21179.6	9810.2
Population	29.6	55.7	47.0	31.4	**187.9**	148.8	73.7	70.3	112.2	62.8	87.8	188.9
Econ. Prod.	761.4	1413.5	1193.5	*791.2*	**4873.0**	3295.9	1818.1	1885.2	2727.3	1603.6	2123.1	4528.8

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of the Midwest and the respective megaregion (or non-megaregion areas).

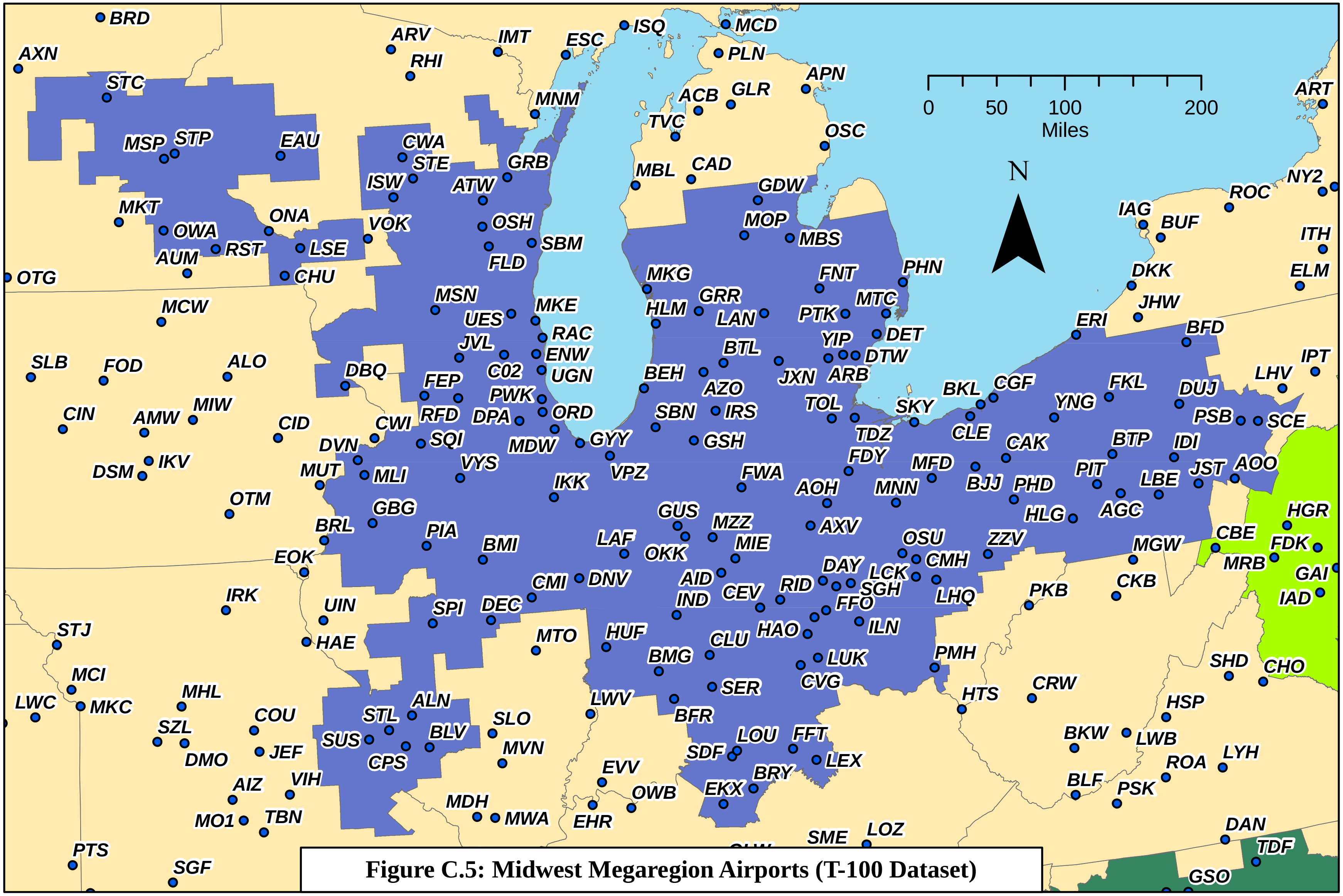

Figure C.5: Midwest Megaregion Airports (T-100 Dataset)

Table C.11: Northeast Passenger Flows

	Passengers (trips)	**Production (trips)**	**Attraction (trips)**
Midwest	687953180	344293511	343659669
International	659618020	328046376	331571644
Southern Florida	499860779	249796626	250064153
Piedmont	348891309	174181563	174709746
Non-Mega	300977817	150814497	150163320
Intramega	255887384		
Southern California	187454212	92375211	95079001
Texas Triangle	172314726	86946199	85368527
Northern California	94100245	46356806	47743439
Gulf Coast	78780409	39499562	39280847
Front Range	74552581	37435551	37117030
Arizona Sun Corridor	41678001	20804490	20873511
Cascadia	28409765	14332579	14077186

Standardized by:	AZ	Casc	FR	Gulf	Mid	Intra-mega	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	377.4	260.7	629.9	659.4	2579.8	**4151.7**	857.0	2878.3	1517.9	4977.8	1177.0	130.5
Population	0.77	0.50	1.37	1.28	6.66	**5.16**	1.51	5.42	2.62	7.78	2.62	2.45
Economic Production	15.0	9.7	26.4	25.3	147.5	**98.8**	29.3	113.4	51.7	156.3	50.5	51.7

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of the Northeast and the respective megaregion (or non-megaregion areas).

Table C.12: Northeast Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
International	68591741110	29965065811	38626675299	25.3%
Midwest	15371924580	7220175272	8151749308	12.1%
Non-Mega	11238465385	5593119840	5645345545	0.9%
Southern California	4749839424	1903305782	2846533642	39.7%
Northern California	2871797987	1326645183	1545152804	15.2%
Southern Florida	2477715657	1022244755	1455470902	35.0%
Piedmont	1949304958	1034205227	915099731	-12.2%
Texas Triangle	1544991136	831863202	713127934	-15.4%
Intramega	1530860378			
Gulf Coast	645703356	276924122	368779234	28.5%
Front Range	475487356	281816787	193670569	-37.1%
Cascadia	348100707	124157028	223943679	57.3%
Arizona Sun Corridor	193087915	103981931	89105984	-15.4%

Stand. by:	AZ	Casc	FR	Gulf	Mid	Intra-mega	NCal	Pied	SCal	SFl	TX	Non-Mega
Area	1748.3	3194.3	4017.1	5404.8	57644.9	**24837.9**	26153.4	16081.3	38460.5	24674.0	10553.1	4871.5
Population	3.6	6.1	8.8	10.5	148.8	**30.9**	46.1	30.3	66.5	38.6	23.5	91.3
Econ. Prod.	69.4	118.9	168.6	207.3	*3295.9*	**590.8**	893.5	633.5	1309.2	774.5	453.2	1929.0

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of the Northeast and the respective megaregion (or non-megaregion areas).

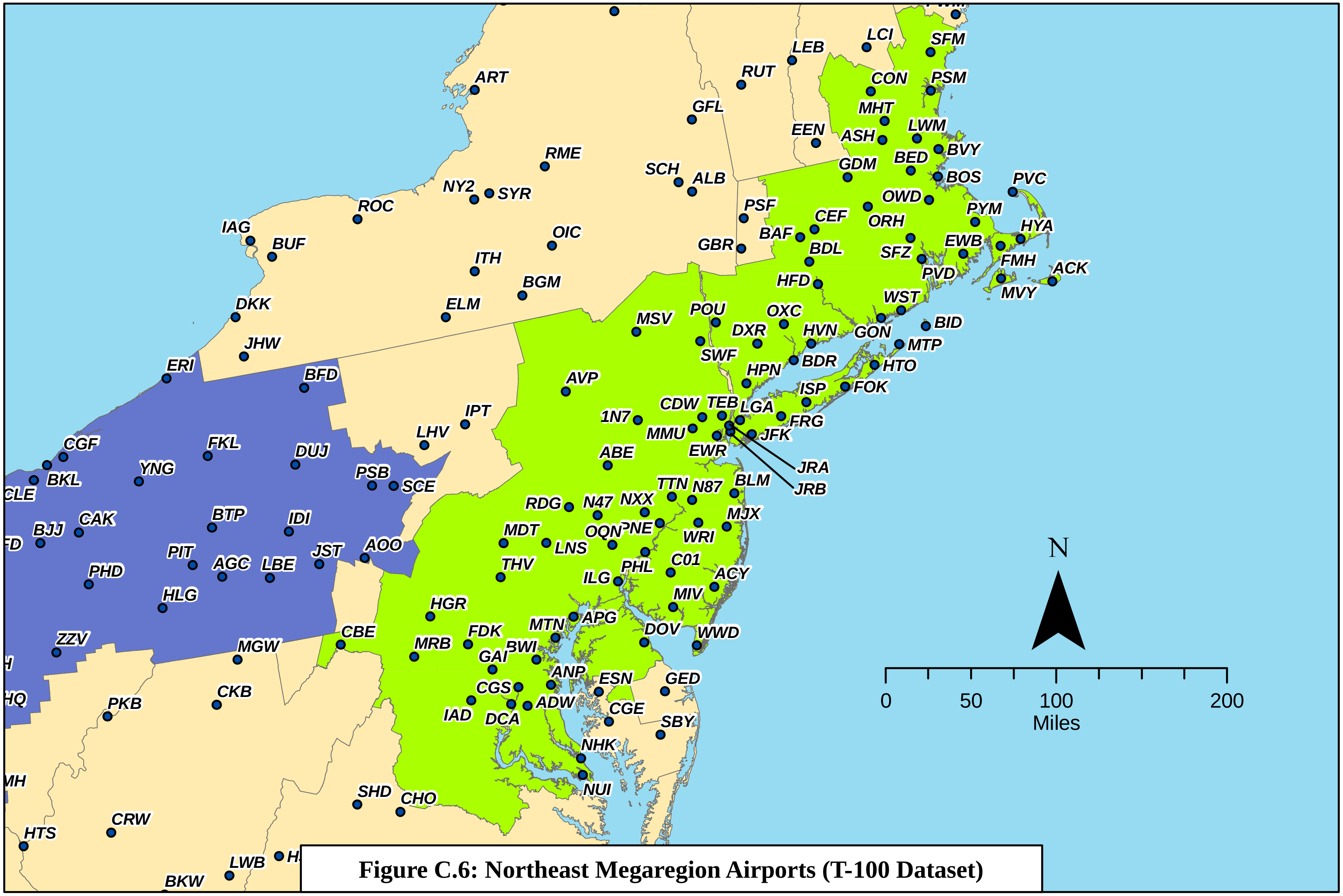

Figure C.6: Northeast Megaregion Airports (T-100 Dataset)

Table C.13: Northern California Passenger Flows

	Passengers (trips)	Production (trips)	Attraction (trips)
Southern California	393508204	196459245	197048959
International	134222145	66975285	67246860
Midwest	121800001	60795476	61004525
Cascadia	117113669	58736427	58377242
Non-Mega	108356594	54276850	54079744
Northeast	94100245	47743439	46356806
Texas Triangle	77686922	38430426	39256496
Arizona Sun Corridor	61997280	30697707	31299573
Front Range	60880788	30015271	30865517
Piedmont	26818217	13720800	13097417
Gulf Coast	22598825	11329761	11269064
Intramega	20130096		
Southern Florida	10098567	5104441	4994126

Standardized by:	AZ	Casc	FR	Gulf	Mid	NE	Intra-mega	Pied	SCal	SFl	TX	Non-Mega
Area	639.3	1226.2	580.4	213.2	481.0	857.0	**417.9**	248.9	3576.1	116.1	584.4	47.2
Population	3.59	5.82	3.49	0.92	1.83	1.51	**1.58**	0.97	11.38	0.37	2.69	1.26
Economic Production	76.2	122.0	71.5	19.7	45.2	29.3	**32.3**	24.2	237.1	8.2	53.9	28.1

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of Northern California and the respective megaregion (or non-megaregion areas).

Table C.14: Northern California Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
International	13360881436	5959587142	7401294294	21.6%
Non-Mega	6002280717	3176410255	2825870462	-11.7%
Midwest	4901606073	2486229117	2415376956	-2.9%
Northeast	2871797987	1545152804	1326645183	-15.2%
Southern California	2482777964	1239291595	1243486369	0.3%
Cascadia	1441057256	832663427	608393829	-31.1%
Texas Triangle	1021873724	526687584	495186140	-6.2%
Front Range	800309212	426590474	373718738	-13.2%
Arizona Sun Corridor	526778396	286536971	240241425	-17.6%
Piedmont	341634071	196631143	145002928	-30.2%
Intramega	316494097			
Southern Florida	261523383	107555899	153967484	35.5%
Gulf Coast	141223840	74289051	66934789	-10.4%

Stand. by:	AZ	Casc	FR	Gulf	Mid	NE	Intra-mega	Pied	SCal	SFl	TX	Non-Mega
Area	5431.8	15087.6	7629.0	1332.2	19358.3	26153.4	**6570.1**	3170.5	22563.1	3007.5	7686.7	2617.0
Population	30.5	71.6	45.8	5.8	73.7	46.1	**24.9**	12.4	71.8	9.5	35.4	69.6
Econ. Prod.	647.1	1501.1	939.3	123.1	1818.1	*893.5*	**508.0**	308.1	1495.6	212.4	709.1	1555.8

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of Northern California and the respective megaregion (or non-megaregion areas).

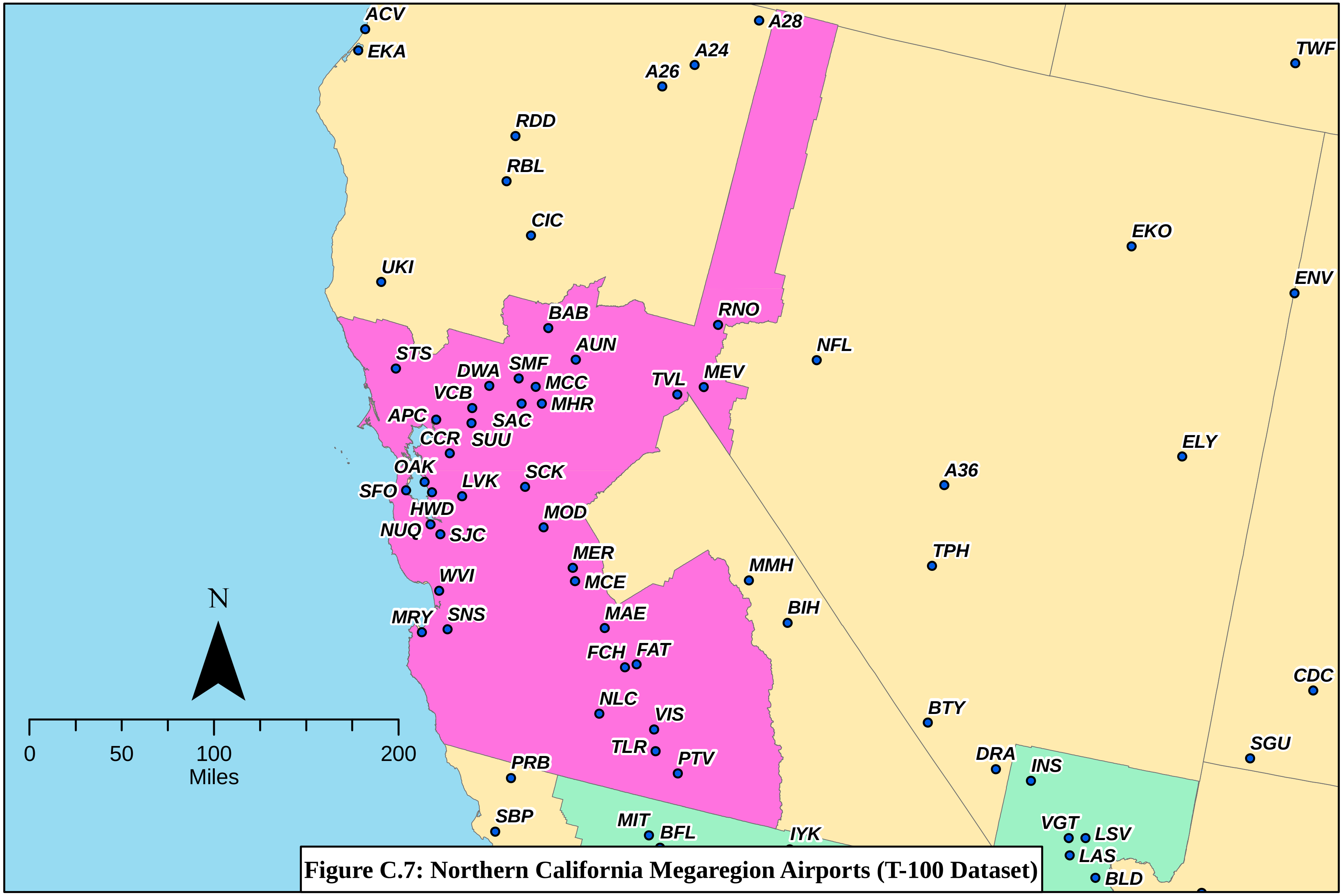

Figure C.7: Northern California Megaregion Airports (T-100 Dataset)

Table C.15: Piedmont Passenger Flows

	Passengers (trips)	Production (trips)	Attraction (trips)
Non-Mega	350542821	175525299	175017522
Northeast	348891309	174709746	174181563
Southern Florida	315663512	158554902	157108610
Midwest	305569547	152515345	153054202
Texas Triangle	125590777	63116181	62474596
International	121341314	60475037	60866277
Intramega	103299958		
Gulf Coast	102506070	51307605	51198465
Southern California	69145817	33741048	35404769
Front Range	30187997	15029541	15158456
Northern California	26818217	13097417	13720800
Arizona Sun Corridor	21431408	10575538	10855870
Cascadia	16486649	7563141	8923508

Standardized by:	AZ	Casc	FR	Gulf	Mid	NE	NCal	Intra-mega	SCal	SFl	TX	Non-Mega
Area	197.7	154.2	259.5	873.0	1154.8	2878.3	248.9	**1733.7**	569.3	3209.1	870.0	152.1
Population	1.11	0.74	1.54	3.85	4.45	5.42	0.97	**6.95**	1.88	10.69	4.05	3.97
Economic Production	31.7	20.0	42.2	101.5	119.4	113.4	24.2	**212.6**	45.4	288.5	96.3	94.2

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of the Piedmont and the respective megaregion (or non-megaregion areas).

Table C.16: Piedmont Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
International	12189089328	5538339935	6650749393	18.3%
Midwest	4824185391	2362407903	2461777488	4.1%
Non-Mega	4723103802	2349205602	2373898200	1.0%
Northeast	1949304958	915099731	1034205227	12.2%
Southern Florida	1643706377	779158418	864547959	10.4%
Southern California	939171587	409094234	530077353	25.8%
Texas Triangle	876848925	459533187	417315738	-9.6%
Cascadia	427362159	159194807	268167352	51.0%
Northern California	341634071	145002928	196631143	30.2%
Gulf Coast	324222975	162571881	161651094	-0.6%
Intramega	303227302			
Front Range	103272180	53754570	49517610	-8.2%
Arizona Sun Corridor	101141844	56908934	44232910	-25.1%

Stand. by:	AZ	Casc	FR	Gulf	Mid	NE	NCal	Intra-mega	SCal	SFl	TX	Non-Mega
Area	933.1	3996.9	887.9	2761.3	18231.0	16081.3	3170.5	**5089.2**	7733.2	16710.1	6074.5	2049.1
Population	5.2	19.2	5.3	12.2	70.3	30.3	12.4	**20.4**	25.6	55.6	28.3	53.5
Econ. Prod.	149.4	519.3	144.4	321.0	1885.2	633.5	*308.1*	**623.9**	616.7	1502.5	672.4	1269.3

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of the Piedmont and the respective megaregion (or non-megaregion areas).

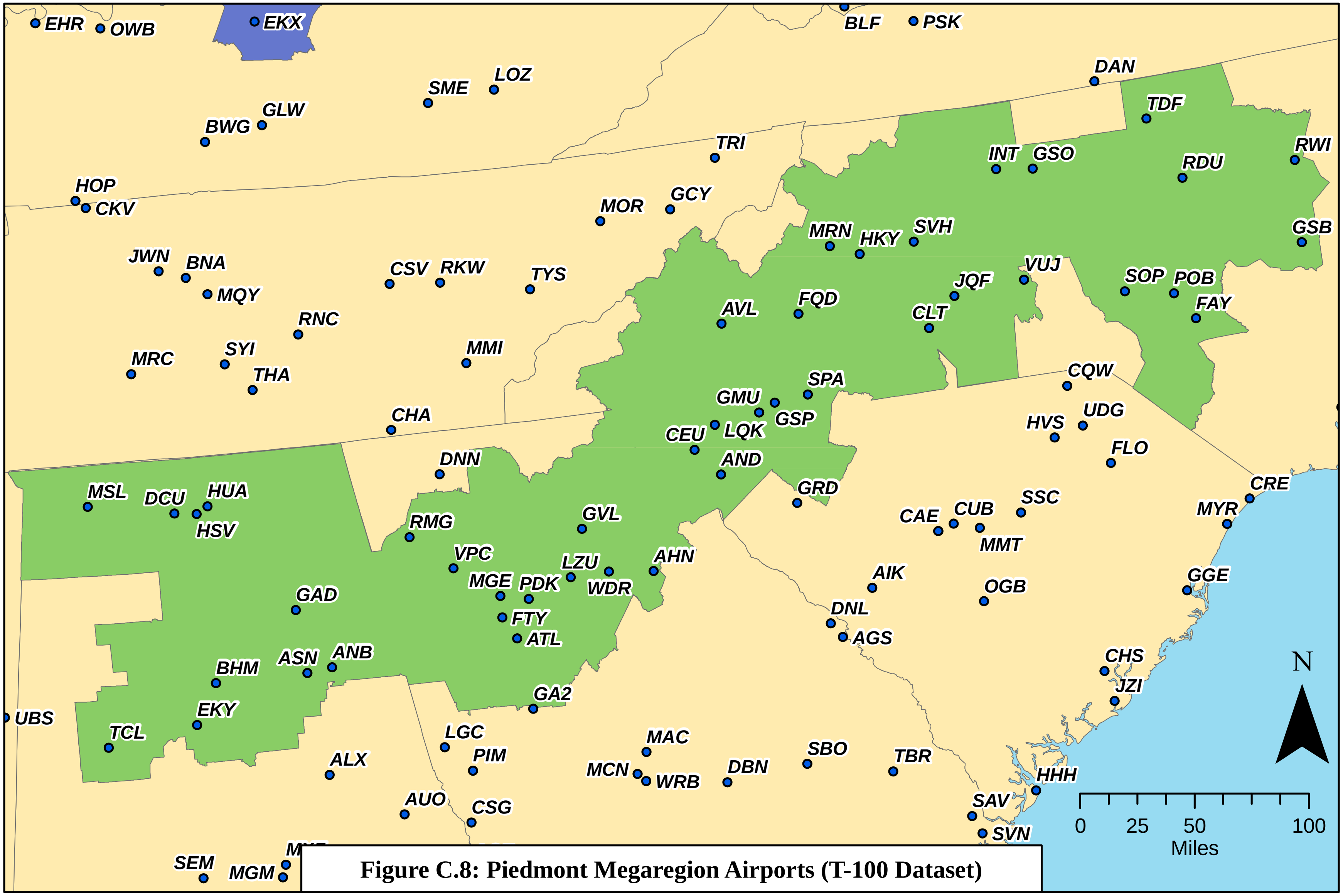

Figure C.8: Piedmont Megaregion Airports (T-100 Dataset)

Table C.17: Southern California Passenger Flows

	Passengers (trips)	Production (trips)	Attraction (trips)
Northern California	393508204	197048959	196459245
International	287299045	144629896	142669149
Midwest	283132159	142309600	140822559
Non-Mega	196506726	98193475	98313251
Northeast	187454212	95079001	92375211
Texas Triangle	175845476	87288998	88556478
Arizona Sun Corridor	161391734	80360583	81031151
Intramega	119118232	119118232	
Cascadia	112478567	55852015	56626552
Front Range	104584778	51877748	52707030
Piedmont	69145817	35404769	33741048
Gulf Coast	58763184	29283986	29479198
Southern Florida	42146047	21232183	20913864

Standardized by:	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	Intra-mega	SFl	TX	Non-Mega
Area	1458.3	1030.0	881.9	490.9	1060.8	1517.9	3576.1	569.3	**1925.5**	418.7	1199.2	85.2
Population	6.11	3.84	3.93	1.75	3.74	2.62	11.38	1.88	**5.45**	1.15	4.63	2.06
Economic Production	131.4	81.9	82.6	37.6	91.0	51.7	237.1	45.4	**114.9**	25.6	94.8	46.0

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of Southern California and the respective megaregion (or non-megaregion areas).

Table C.18: Southern California Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
International	33100413391	13863833292	19236580099	32.5%
Non-Mega	11422204121	5622355461	5799848660	3.1%
Midwest	8481821935	4457924707	4023897228	-10.2%
Northeast	4749839424	2846533642	1903305782	-39.7%
Northern California	2482777964	1243486369	1239291595	-0.3%
Texas Triangle	2248608832	1196478483	1052130349	-12.8%
Cascadia	1116982985	607738398	509244587	-17.6%
Piedmont	939171587	530077353	409094234	-25.8%
Southern Florida	915686567	424878395	490808172	14.4%
Front Range	913121082	441254629	471866453	6.7%
Arizona Sun Corridor	857589544	489088894	368500650	-28.1%
Gulf Coast	471611860	237088294	234523566	-1.1%
Intramega	388561448	388561448		

Stand. by:	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	Intra-mega	SFl	TX	Non-Mega
Area	7748.8	10228.2	7699.4	3940.0	31779.4	38460.5	22563.1	7733.2	**6280.8**	9097.8	15334.9	4950.6
Population	32.5	38.2	34.3	14.0	112.2	66.5	71.8	25.6	**17.8**	25.1	59.2	119.8
Econ. Prod.	698.4	812.9	721.3	302.1	2727.3	1309.2	1495.6	*616.7*	**374.7**	556.6	1212.2	2673.7

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of Southern California and the respective megaregion (or non-megaregion areas).

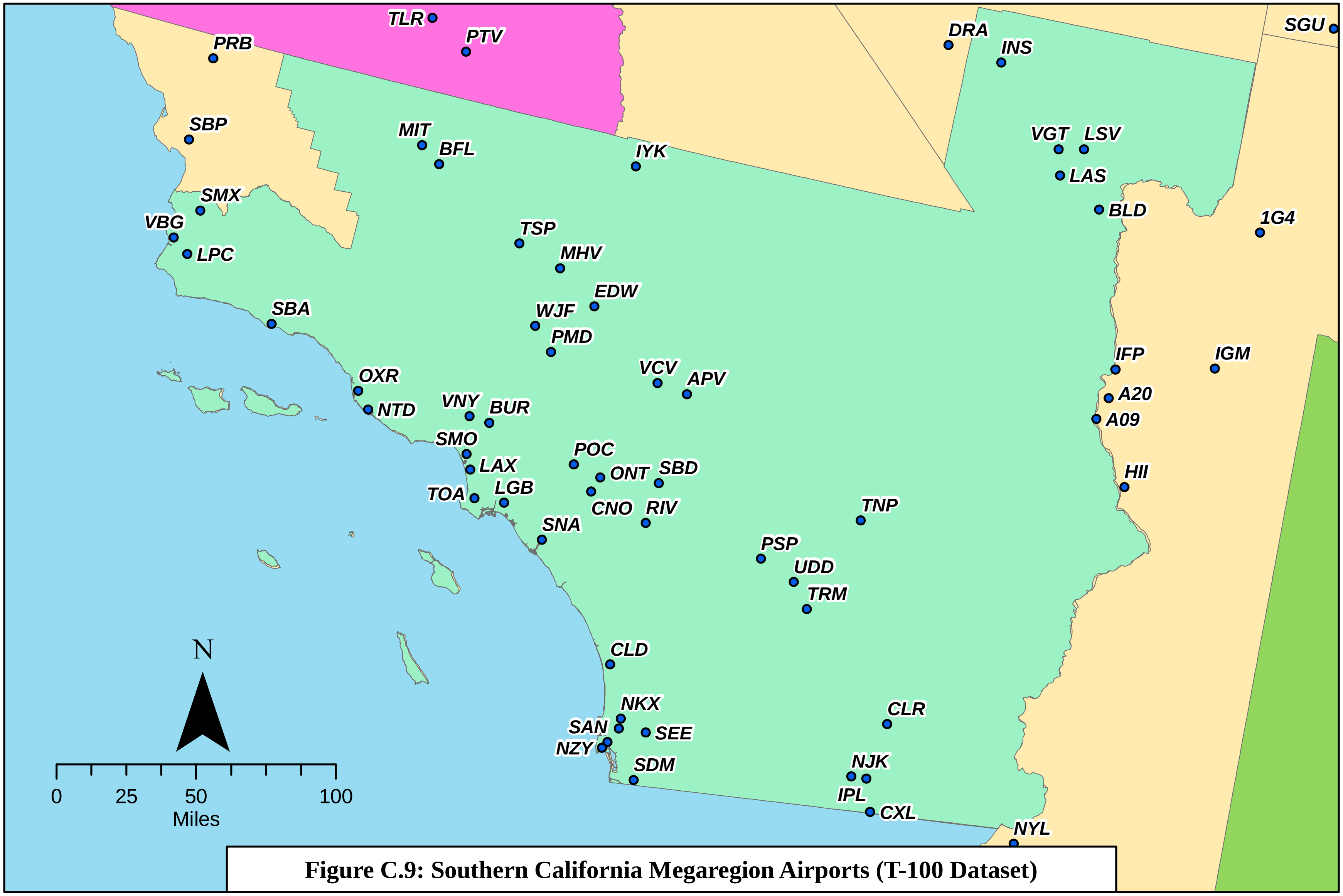

Figure C.9: Southern California Megaregion Airports (T-100 Dataset)

Table C.19: Southern Florida Passenger Flows

	Passengers (trips)	Production (trips)	Attraction (trips)
Northeast	499860779	250064153	249796626
International	355652334	177339333	178313001
Midwest	323291470	162441598	160849872
Piedmont	315663512	157108610	158554902
Texas Triangle	125551778	63560936	61990842
Non-Mega	104949985	52177451	52772534
Gulf Coast	63732366	31905780	31826586
Intramega	55891075		
Southern California	42146047	20913864	21232183
Front Range	21959526	10961749	10997777
Northern California	10098567	4994126	5104441
Arizona Sun Corridor	8375153	4126398	4248755
Cascadia	3846691	1907590	1939101

Standardized by:	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	Intra-mega	TX	Non-Mega
Area	95.6	44.7	229.9	659.6	1326.0	4977.8	116.1	3209.1	418.7	**1441.1**	1016.2	45.9
Population	0.44	0.17	1.13	2.41	4.72	7.78	0.37	10.69	1.15	**3.81**	4.07	1.19
Economic Production	10.5	4.1	26.2	56.3	120.6	156.3	8.2	288.5	25.6	**91.9**	88.0	27.3

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of Southern Florida or and the respective megaregion (or non-megaregion areas).

Table C.20: Southern Florida Freight Flows

	Freight (lbs)	**Production (lbs)**	**Attraction (lbs)**	**% Difference**
International	51579177100	24040060904	27539116196	13.6%
Non-Mega	5885882057	2778367192	3107514865	11.2%
Midwest	4299350997	1932108492	2367242505	20.2%
Northeast	2477715657	1455470902	1022244755	-35.0%
Piedmont	1643706377	864547959	779158418	-10.4%
Texas Triangle	1339292730	639063139	700229591	9.1%
Southern California	915686567	490808172	424878395	-14.4%
Intramega	396491414	396491414		
Gulf Coast	330805826	191704354	139101472	-31.8%
Northern California	261523383	153967484	107555899	-35.5%
Cascadia	90111295	43129815	46981480	8.5%
Front Range	81033994	55945970	25088024	-76.2%
Arizona Sun Corridor	34337377	18249650	16087727	-12.6%

Stand. by:	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	Intra-mega	TX	Non-Mega
Area	392.0	1046.3	848.4	3423.9	17633.6	24674.0	3007.5	16710.1	9097.8	**10223.1**	10839.9	2576.8
Population	1.8	4.1	4.2	12.5	62.8	38.6	9.5	55.6	25.1	**27.0**	43.5	66.7
Econ. Prod.	43.0	95.4	96.8	292.2	1603.6	774.5	212.4	1502.5	*556.6*	**652.1**	939.2	1531.6

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of Southern Florida and the respective megaregion (or non-megaregion areas).

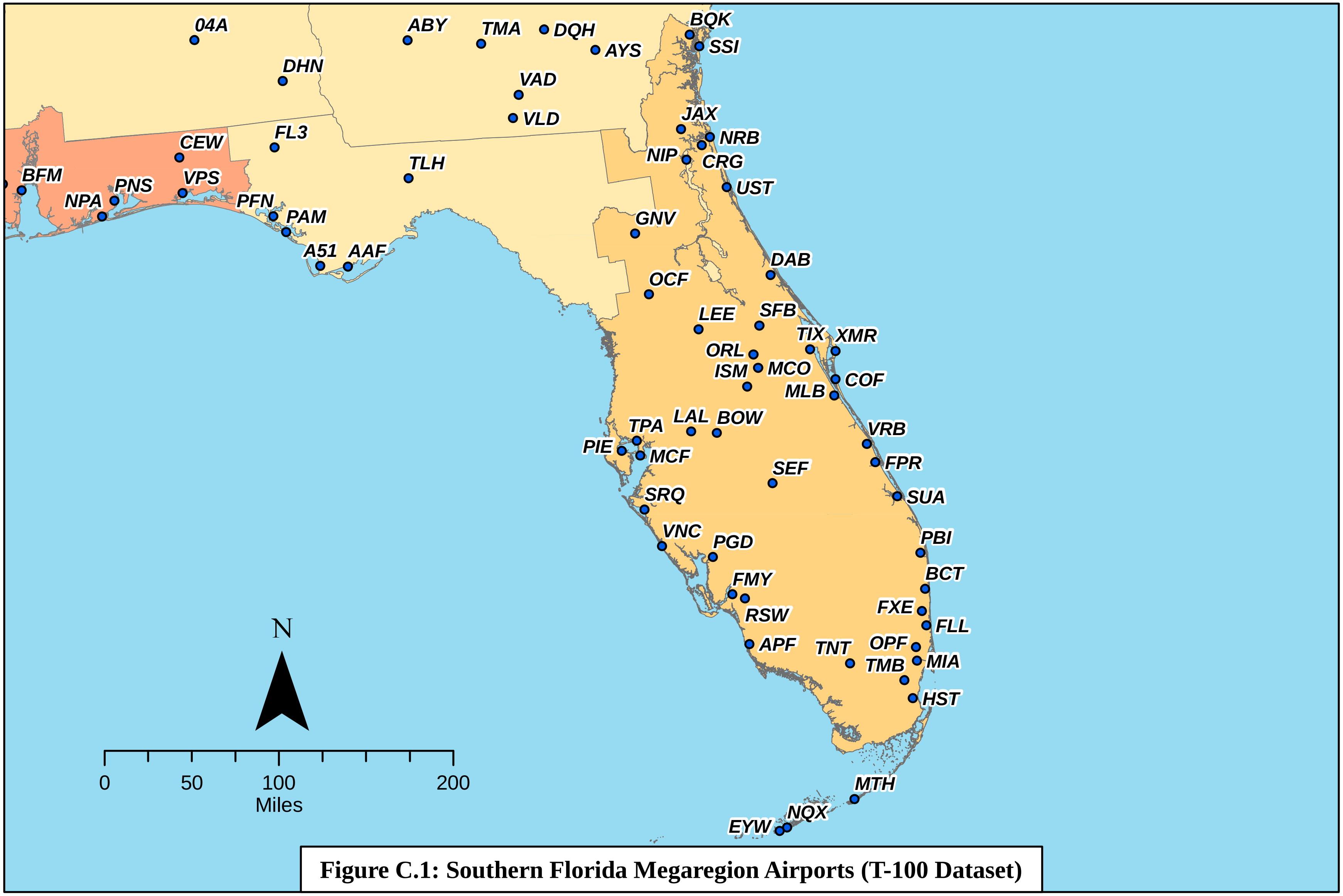

Figure C.1: Southern Florida Megaregion Airports (T-100 Dataset)

Table C.21: Texas Triangle Passenger Flows

	Passengers (trips)	Production (trips)	Attraction (trips)
Non-Mega	320268346	159901157	160367189
Midwest	225308290	112264050	113044240
Gulf Coast	221642113	110838669	110803444
Intramega	185872799		
Southern California	175845476	88556478	87288998
Northeast	172314726	85368527	86946199
International	166317584	83096713	83220871
Piedmont	125590777	62474596	63116181
Southern Florida	125551778	61990842	63560936
Front Range	95577679	48359837	47217842
Northern California	77686922	39256496	38430426
Arizona Sun Corridor	66767018	33702154	33064864
Cascadia	34561284	17600321	16960963

Standardized by:	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	Intra-mega	Non-Mega
Area	499.8	261.6	675.5	1569.7	777.5	1177.0	584.4	870.0	1199.2	1016.2	**2192.7**	137.4
Population	3.23	1.47	4.58	8.03	3.22	2.62	2.69	4.05	4.63	4.07	**11.52**	3.57
Economic Production	66.2	29.9	91.3	166.8	77.9	50.5	53.9	96.3	94.8	88.0	**227.2**	79.0

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of the Texas Triangle and the respective megaregion (or non-megaregion areas).

Table C.22: Texas Triangle Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
International	11642243067	5761790267	5880452800	2.0%
Midwest	6137856670	2841262568	3296594102	14.8%
Non-Mega	5510059571	2584495753	2925563818	12.4%
Southern California	2248608832	1052130349	1196478483	12.8%
Northeast	1544991136	713127934	831863202	15.4%
Southern Florida	1339292730	700229591	639063139	-9.1%
Northern California	1021873724	495186140	526687584	6.2%
Gulf Coast	1011230703	532414366	478816337	-10.6%
Piedmont	876848925	417315738	459533187	9.6%
Intramega	873741146			
Front Range	358154639	244659844	113494795	-73.2%
Arizona Sun Corridor	288790999	159755505	129035494	-21.3%
Cascadia	241388269	116771927	124616342	6.5%

Stand. by:	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	Intra-mega	Non-Mega
Area	2162.0	1827.2	2531.1	7096.1	21179.6	10553.1	7686.7	6074.5	15334.9	10839.9	**10307.4**	2364.7
Population	14.0	10.3	17.2	36.3	87.8	23.5	35.4	28.3	59.2	43.5	**54.2**	61.5
Econ. Prod.	286.2	209.0	342.1	754.0	2123.1	453.2	709.1	672.4	1212.2	*939.2*	**1068.1**	1359.5

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of the Texas Triangle and the respective megaregion (or non-megaregion areas).

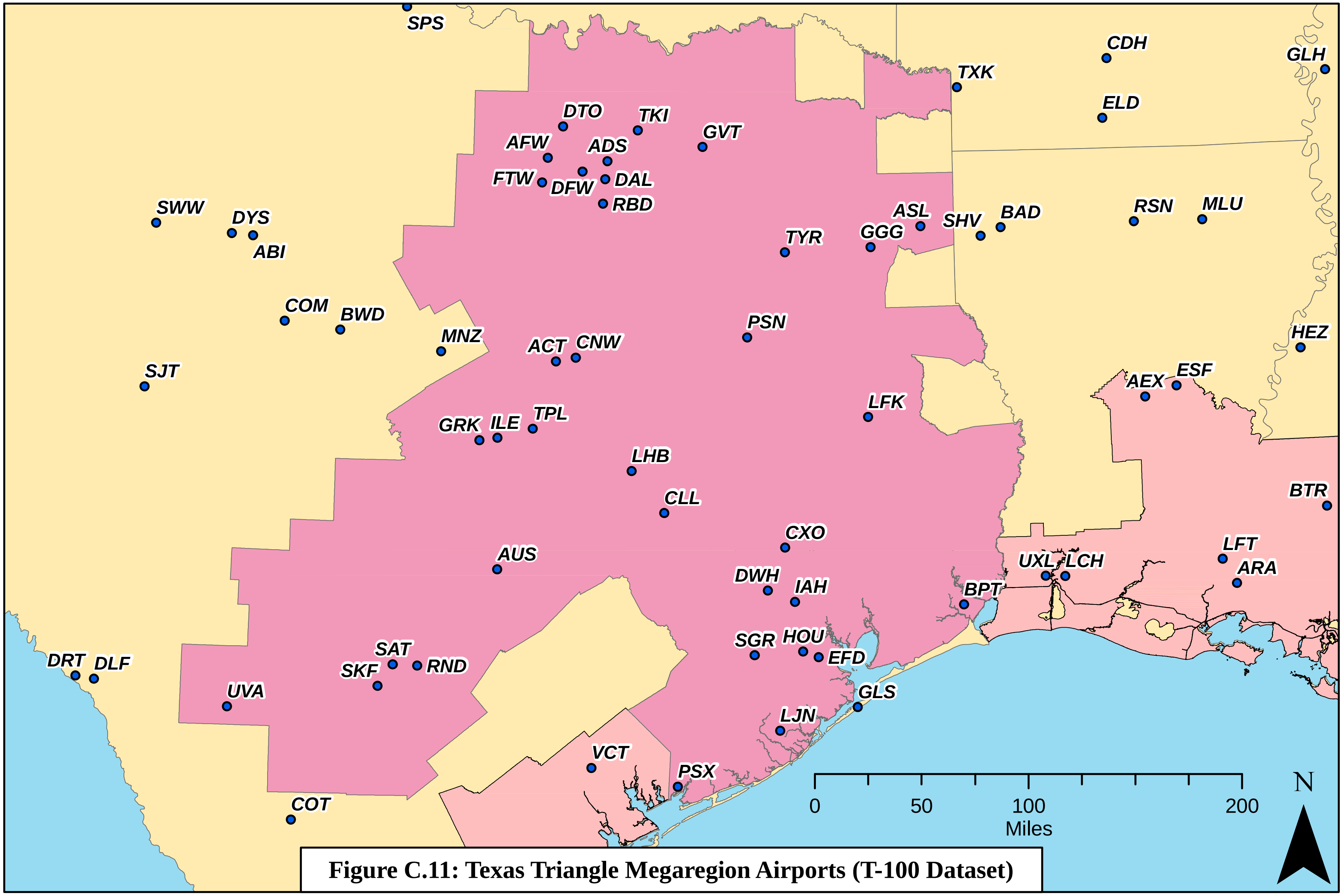

Figure C.11: Texas Triangle Megaregion Airports (T-100 Dataset)

Table C.23: Non-megaregion Areas Passenger Flows

	Passengers (trips)	Production (trips)	Attraction (trips)
Midwest	560354045	280738966	279615079
Piedmont	350542821	175017522	175525299
Internal Non-Mega	322069219		
Texas Triangle	320268346	160367189	159901157
Northeast	300977817	150163320	150814497
International	205155088	102880873	102274215
Southern California	196506726	98313251	98193475
Cascadia	135909270	68322524	67586746
Front Range	135583415	67831393	67752022
Northern California	108356594	54079744	54276850
Southern Florida	104949985	52772534	52177451
Gulf Coast	98445200	49204195	49241005
Arizona Sun Corridor	71321157	35476660	35844497

Standardized by:	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Internal Non-Mega
Area	31.1	59.3	58.9	42.7	228.7	130.5	47.2	152.1	85.2	45.9	137.4	**143.4**
Population	0.91	1.68	1.73	1.15	4.40	2.45	1.26	3.97	2.06	1.19	3.57	**4.38**
Economic Production	20.8	38.0	39.1	26.2	105.6	51.7	28.1	94.2	46.0	27.3	79.0	**99.6**

Note: Standardized flow are in trips per square mile, per capita, and per $ trillion GMP of non-megaregion areas and the respective megaregion.

Table C.24: Non-megaregion Areas Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
International	30619685926	12179623789	18440062137	40.9%
Midwest	24039018436	12548983487	11490034949	-8.8%
Internal Non-Mega	15342467222			
Southern California	11422204121	5799848660	5622355461	-3.1%
Northeast	11238465385	5645345545	5593119840	-0.9%
Northern California	6002280717	2825870462	3176410255	11.7%
Southern Florida	5885882057	3107514865	2778367192	-11.2%
Texas Triangle	5510059571	2925563818	2584495753	-12.4%
Piedmont	4723103802	2373898200	2349205602	-1.0%
Cascadia	3814413745	1942473340	1871940405	-3.7%
Gulf Coast	2200242966	1286920752	913322214	-34.0%
Front Range	1922919768	1061803827	861115941	-20.9%
Arizona Sun Corridor	1343019943	675851951	667167992	-1.3%

Standardized by:	AZ	Casc	FR	Gulf	Mid	NE	NCal	Pied	SCal	SFl	TX	Internal Non-Mega
Area	585.4	1663.7	835.3	955.3	9810.2	4871.5	2617.0	2049.1	4950.6	2576.8	2364.7	**6832.9**
Population	17.2	47.1	24.6	25.8	188.9	91.3	69.6	53.5	119.8	66.7	61.5	**208.7**
Economic Production	392.0	1067.9	555.1	585.3	4528.8	1929.0	1555.8	1269.3	2673.7	1531.6	1359.5	**4742.6**

Note: Standardized flow are in pounds of freight per square mile, per capita, and per $ trillion GMP of non-megaregion areas and the respective megaregion.

Table C.25: International Passenger Flows

	Passengers (trips)	Production (trips)	Attraction (trips)
Northeast	659618020	331571644	328046376
Southern Florida	355652334	178313001	177339333
Midwest	290824582	146694701	144129881
Southern California	287299045	142669149	144629896
Non-Mega	205155088	102274215	102880873
Texas Triangle	166317584	83220871	83096713
Northern California	134222145	67246860	66975285
Piedmont	121341314	60866277	60475037
Gulf Coast	89645158	44794478	44850680
Cascadia	44265462	22353424	21912038
Front Range	19542018	9884582	9657436
Arizona Sun Corridor	18073361	8888691	9184670
International	n/a	n/a	n/a

Table C.26: International Freight Flows

	Freight (lbs)	Production (lbs)	Attraction (lbs)	% Difference
Northeast	68591741110	38626675299	29965065811	-25.3%
Southern Florida	51579177100	27539116196	24040060904	-13.6%
Midwest	38671772113	21306191840	17365580273	-20.4%
Southern California	33100413391	19236580099	13863833292	-32.5%
Non-Mega	30619685926	18440062137	12179623789	-40.9%
Northern California	13360881436	7401294294	5959587142	-21.6%
Piedmont	12189089328	6650749393	5538339935	-18.3%
Texas Triangle	11642243067	5880452800	5761790267	-2.0%
Gulf Coast	4910028163	2145331852	2764696311	25.2%
Cascadia	3696275053	1591023784	2105251269	27.8%
Front Range	287133073	151424238	135708835	-10.9%
Arizona Sun Corridor	169834839	86585898	83248941	-3.9%
International	n/a	n/a	n/a	n/a

Table C.27: Piedmont Passenger Growth Over Time

	Year								
Flow Type	1990	1991	1992	1993	1994	1995	1996	1997	1998
Large to Large	737714	555425	572943	588402	718393	694562	892709	938443	871023
Large to M/S/N*	3632735	3101226	3370988	3728181	4517335	4668108	4879841	5043563	5236786
Large to N-P*	0	0	0	64	0	0	0	0	0
M/S/N to M/S/N	134727	106967	114666	112780	80324	28953	4934	1766	2360
M/S/N to N-P	0	0	0	0	0	30	0	0	0
N-P to N-P	0	0	0	0	0	0	0	0	0
TOTAL	4505176	3763618	4058597	4429427	5316052	5391653	5777484	5983772	6110169

	Year									
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Large to Large	871727	850382	712921	678975	664678	671670	885267	1059770	1359562	1371588
Large to M/S/N	5228630	5383583	4794439	4590647	4805141	4824137	4885566	4626156	4681129	4796938
Large to N-P	0	0	0	4488	1675	15792	37605	18863	19787	6839
M/S/N to M/S/N	1824	4530	24527	5392	4679	18274	8587	3078	27559	13152
M/S/N to N-P	0	0	0	556	381	148	458	371	279	460
N-P to N-P	0	0	0	97	160	66	36	0	445	996
TOTAL	6102181	6238495	5531887	5280155	5476714	5530087	5817519	5708238	6088761	6189973

Note: All flows in number of trips.

**M/S/N = Medium/Small/Non-hub primary airports*

**N-P = Non-primary airport*

Table C.28: Piedmont Freight Growth Over Time

Flow Type	1990	1991	1992	1993	1994	1995	1996	1997	1998
Large to Large	5625138	3826361	3674417	3465572	2870511	2243303	2552857	2562877	2504873
Large to M/S/N*	26732815	17678338	17420334	17799051	16439810	13369562	13557317	13734282	12067964
Large to N-P*	0	0	0	575	0	0	0	0	0
M/S/N to M/S/N	437213	342068	360373	380257	185143	44707	18604	2093	3425
M/S/N to N-P	0	0	0	0	0	0	0	0	0
N-P to N-P	0	0	0	0	0	0	0	0	0
TOTAL	32795166	21846767	21455124	21645455	19495464	15657572	16128778	16299252	14576262

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Large to Large	2296772	1667041	1433902	2426579	4179906	2696396	3552456	2093770	4116871	1250514
Large to M/S/N	11822939	10504743	9172920	9810420	11316592	11709629	8472386	9007353	6260464	6088997
Large to N-P	0	0	0	22496	7107	68298	47593	49498	46919	17512
M/S/N to M/S/N	2846	3680	70954	254765	749250	405556	703011	111540	325372	507277
M/S/N to N-P	0	0	0	0	0	0	0	1268	10136	0
N-P to N-P	0	0	0	0	2500	36042	0	3192	0	0
TOTAL	14122557	12175464	10677776	12514260	16255355	14915921	12775446	11266621	10759762	7864300

Note: All flows in pounds of freight.
**M/S/N = Medium/Small/Non-hub primary airports*
**N-P = Non-primary airport*

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